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SOIL SERIES SURVEY OF SELECTED STUDY AREAS IN THAILAND

APPENDIX A: SOIL SURVEY OF THE NAKHON SAWAN AREA

by

Lek Moncharoen

Manu Omakupt

Under the direction of

F. R. Moormann

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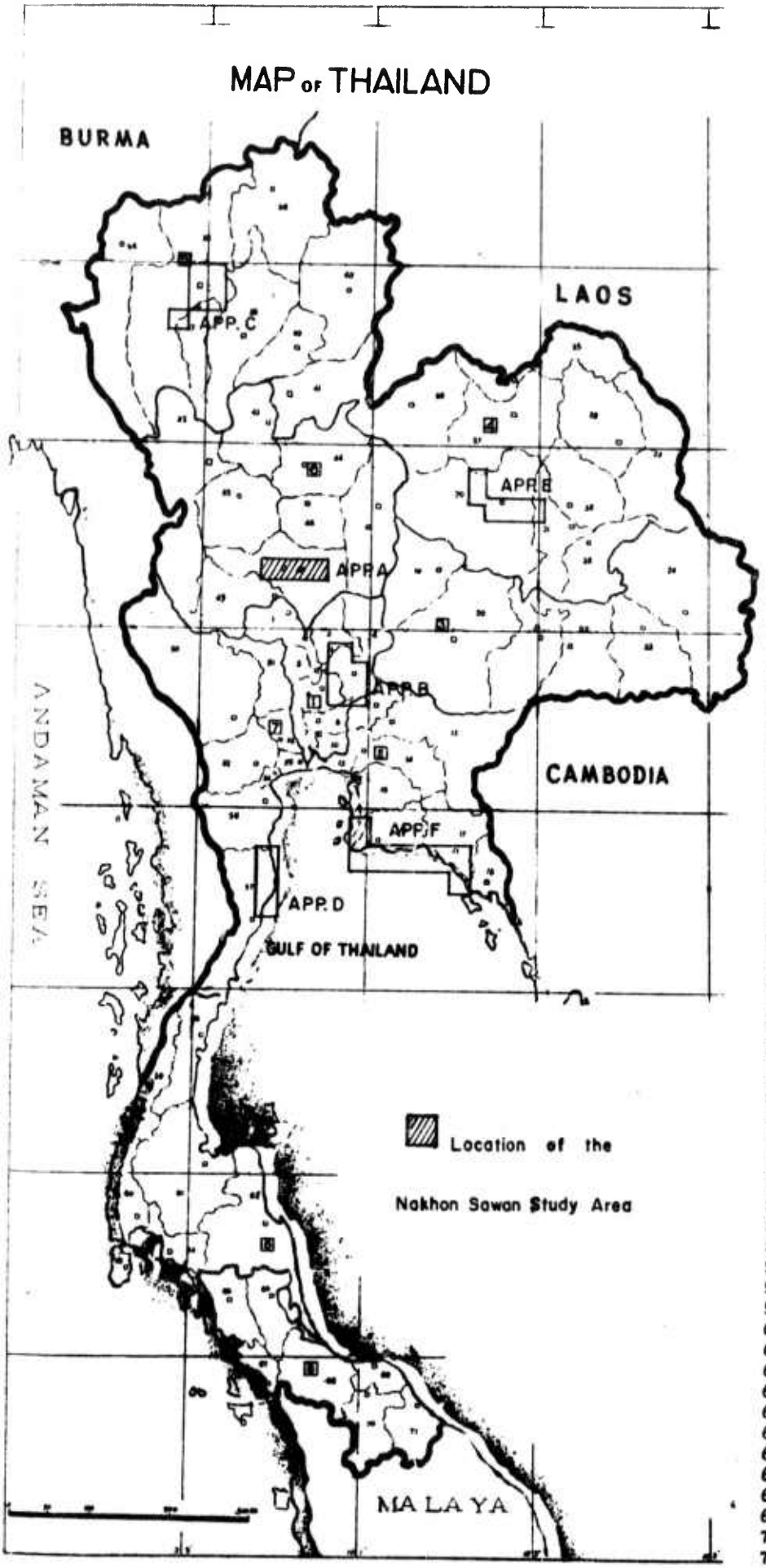

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3	Lopburi	
4	Sara-buri	
5	Ang-thong	
6	Ayuthya	
7	Nonthaburi	
8	Pathum-thani	
9	Thonburi	
10	Phra-nakhorn	
11	Nakhornayok	
12	Prachinburi	
13	Samutprakan	
14	Cha-choengsao	
15	Cholburi	
16	Rayong	
17	Chant-buri	
18	Trat	
19	Chayaphum	
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21	Buriram	
22	Surin	
23	Srisaket	
24	Ubonratthani	
25	Nong-kai	
26	Loei	
27	Udornthani	
28	Sakonnakhorn	
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APPENDIX A: SOIL SURVEY OF THE NAKHON SAWAN AREA

INTRODUCTION

The soil survey of the Nakhon Sawan study area was conducted during the period April to September 1965, and covered an area of approximately 2,965 sq km (1,145 sq mi). Reconnaissance was made along all accessible roads and tracks. Soils were studied at road cuts and borrow pits and at exposures along drainage channels. Borings were made and pits were excavated, usually to a depth of 100 cm, in selected areas to study the soil profiles in greater detail. Approximately 8 to 10 observations per square kilometer were made.

Detailed field data were used to map soil boundaries on air photos at scales of 1:20,000 and 1:60,000; then the soil boundaries were transferred from the air photos to series L 708 Army Map Service topographic maps at a scale of 1:50,000 *. Soil characteristics for those areas not examined in the field were determined by air-photo interpretation techniques. Air photos were not available for a small area along the southern boundary of the study area, and the soil characteristics (including boundaries) for this area were determined by field observation and by interpretation of the series L 708 topographic maps. New air photos on scale 1:5,000 were available for the middle portion of the study area. These photos were occasionally used for checking certain topographical details and for correcting doubtful soil boundaries.

During the survey, field work was under the direction of Messrs. Lek Moncharoen and Manu Omakupt. Dr. F. R. Moormann, Food and Agriculture Organization (FAO), and Prof. Santhad Rojanasoonthon, Kasetsart University, assisted in the establishment of the soil legend. Mr. F.J. Dent assisted in the editing of the map and the preparation of the report.

LOCATION OF AREA

The study area is located in the northern part of the Central Plain where the Mae Nam Nan and Mae Nam Ping converge to form the Mae Nam Chao Phraya.

* Proper names in this report are spelled as they appear on these maps.

Practically the entire study area is situated within Nakhon Sawan province; however, very small scattered areas occupy portions of the procinces of Kamphaeng Phet, Phichit, and Uthai Thani. The area appears on map sheets 4957-I; 4958-I and-II; 5057-I and-IV; and 5058-I,-II,-III, and-IV. The study area is rectangular in shape, with the long axis extending in an east-west direction, and is bounded by latitudes 15° 35' N and 15° 55' N and longitudes 99° 45' E and 100° 30' E.

TRANSPORTATION ROUTES

All important land routes between Bangkok and northern Thailand pass through the Nakhon Sawan study area. The area is served by a major highway and railway and by several major waterways. In addition, air service to Bangkok and northern Thailand is available from a commercial airfield located at Changwat Nakhon Sawan (Nakhon Sawan)*, the principal town of the study area.

National Highway No. 5 (Thanon Phahon Yothin) and the Northern Line of the State Railways (Thang Rot Fai Sai Nua) pass through Nakhon Sawan. Three loose-surfaced all-weather roads stem from National Highway No. 5, but all other routes in the area are unsurfaced, fair-weather roads and tracks which are negotiable only during the dry season. Thus, most of the local travel throughout the study area is by inland waterway. Villages are to a large extend concentrated along the banks of navigable streams and canals.

A fairly extensive system of natural and man-made navigable waterways extends throughout most of the study area. Three of the most important streams in Thailand form the backbone of this system--the Mae Nam Chao Phraya, the Mae Nam Nan, and the Mae Nam Ping. Numerous tributaries and irrigation canals stem from these three streams. In addition, a large lake west of Nakhon Sawan, Bung Boraphet, occupies an extensive part of the study area and is used primarily for fishing.

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* Populated places are spelled in this manner the first time they appear, followed by an abbreviated form in parentheses. Thereafter, only the abbreviated form is used in the text.

TOPOGRAPHY AND PHYSIOGRAPHY

The topography of the Nakhon Sawan study area is predominantly flat to slightly undulating or undulating. Nearly half of the area is occupied by the alluvial plains of the Mae Nam Chao Phraya river system (1)*. Isolated hills (monadnocks) are scattered throughout the study area and a fairly large range of hills is located near the southwestern border. An undulating peneplain is found southeast of Nakhon Sawan. A number of distinct topographical units were distinguished: hills, peneplains, terraces, and alluvial plains.

Hills

The following types of hills were differentiated on the basis of rock type.

a. Andesite and rhyolite porphyry hills. Isolated andesite and rhyolite porphyry hill formations are found in the southeastern part of the study area. These hills are generally rounded in shape; some are symmetrical or cone shaped. Few rock outcrops are found on the side slopes of these hills.

b. Granitic or granodiorite hills. The only large hill mass in the study area, Khao Luang, located southwest of Nakhon Sawan, is composed of granitic rocks. Associated with this granitic mass are low hills of limestone, mica schist, and phyllite. These hills are rounded in shape and have characteristic boulder outcrops exposed on their side slopes.

c. Limestone hills. Isolated craggy limestone hills are scattered throughout the plains and the peneplain area but occur mainly along the western boundary of the study area and along the eastern side of the Khao Luang granitic hill range. These hills occur as pinnacle buttes, with very steep cliff faces much fluted and pitted by solution. Rock is exposed over large surfaces of these hills.

d. Mica schist hills. The main occurrences of these hills are immediately to the west of Nakhon Sawan and directly south of Nakhon Sawan adjacent to the southern edge of the study area. These hills are composed primarily of mica schist and

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* Numerals in parentheses refer to similarly numbered items in the Literature Cited at the end of this report.

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quartzite; however, limestone occurs in association with these rocks in the hills south of Nakhon Sawan. The hills are normally rounded and low and marked with erosional channels and V-shaped valleys. Few rock outcrops are found on the side slopes.

Peneplains

A peneplain, which is part of a large peneplain formation extending to the south and east of the study area, occupies a fairly extensive area southeast of Nakhon Sawan. The topography is predominantly undulating but in a few places, low hills protrude. The peneplain is composed of shallow clayey materials overlying bedrock and is often covered by a shallow layer of gravelly residuum. Composition of the bedrock varies strongly; the low hills are composed of shale, quartzite, and andesite.

Terraces

Terraces occupy most of the western half and a significant portion of the easternmost part of the study area. Four classes of terraces were recognized; they are discussed as follows :

a. Terraces adjacent to limestone hills. These terraces are found adjacent to the limestone hills and are commonly composed of clay-textured materials. Marl concretions and limestone fragments are also found in the higher parts of these formations in association with sedentary and local colluvial materials. The topography is flat in low-lying areas and undulating in the higher parts.

b. High terraces. High terraces occur only in one relatively small area along the western border of the study area. They have a slightly undulating topography. This higher terrace level may well coincide with the middle terrace level of Northeastern Thailand (appendix E, Khon Kaen study area).

c. Low terraces. Low terraces are slightly higher than the semi-recent terrace formations and occupy most of the western part of the study area. Occurrences of these terraces are also found in the southeastern part of the study area. The lower parts of these terraces are flat and usually cultivated in rice, whereas the higher parts, including the colluvial footslopes around the Khao Luang hill range, are undulating and are used for dryland crop agriculture or are uncultivated and overgrown with low shrubs.

d. Semirecent terraces. These terraces are slightly higher than the adjacent recent river plains; however, the transition between the two landscapes is usually very gradual and smooth. The topography is flat to slightly undulating. Occurrences of these terraces are found throughout the study area, but a large semi-recent terrace occupies an extensive portion of the easternmost part of the area.

Alluvial plains

Extensive alluvial plains have been formed by the Mae Nam Chao Phraya, the Mae Nam Nan, and the Mae Nam Ping and their tributaries. Continuous shifting of these streams has resulted in the formation of abandoned channels, oxbows, levees, and point bars. Bung Boraphet, a backswamp lake, occupies a significant part of the plains east of Nakhon Sawan. Most smaller streams have narrow U-shaped valleys which are filled with materials of varying texture and composition; the valleys in the southeastern part of the study area often contain weathered limestone fragments.

SURFACE GEOLOGY

A large part of the study area is composed of recent unconsolidated Quaternary deposits with outcrops of rocks formed in early Carboniferous, Devonian, and Silurian; pre-Permian; Permian and Carboniferous; Triassic; and late Tertiary periods*.

Early Carboniferous, Devonian, and Silurian

Most of the rocks formed during this period are phyllites and slates with quartzite bands. Quartzite phyllite rocks of the Kanchanaburi geologic series (2) are found near mica schist rocks and sometimes occur in association with them.

Pre-Permian

Rocks of pre-Permian origin were subjected to metamorphism and are generally composed of para schist, phyllite, slate, and some quartzite; however, intrusions of andesite and diorite, occurring in bosses and stocks, are sometimes found.

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* Being quarried for industrial purposes and for use as road surfacing.

Permian and Carboniferous

Rat Buri limestone was formed during these periods. It is a massive, light gray, crystalline limestone and is interbedded in places with shale and phyllite.

Triassic

Granitic rocks, probably granodiorite, are assigned to this period. These rocks are found only in the Khao Luang hill range and appear to occur as a younger intrusion of the limestone and mica schist formations.

Late Tertiary

Andesite and rhyolite porphyry are thought to have been formed in late Tertiary times and are found as stocks and dikes; andesite appears to be the dominant rock. The andesite is green or purple and the rhyolite is buff or yellow in color. Granular-textured dioritic and aphanitic-textured basaltic rocks are also found in association with the andesite and rhyolite formations.

Quaternary

Recent Quaternary deposits of river alluvium have been laid down unconformably by the Mae Nam Chao Phraya river system. The nature of the deposits is due very largely to the effects of the Ice Age. While no evidence of actual glacial activity has been found in Thailand, the waxing and waning of the ice sheets in other parts of the world caused climatic changes and a rise and fall in base level. Alternating periods of erosion and sedimentation have resulted in the formation of peneplains and river terraces. The most recent formations are the alluvial plains of the main streams and their tributaries.

CLIMATE

The Nakhon Sawan study area has a tropical savanna climate (Koppen "Aw") with distinct wet and dry seasons. With the exception of a slightly lesser rainfall in the western part of the study area, the climate of the area is well represented by the Nakhon Sawan station.* The average annual rainfall for

* Statistical data were obtained from the Climatological Division, Meterorological Department, Bangkok, Thailand.

Nakhon Sawan is 1,187 mm.* The heaviest rainfall is from May to October when the area is under the influence of the southwest monsoon. September is the wettest month with an average rainfall of 273 mm. The dry season is from November to April, during which time periods of up to one month without rainfall are quite common. The average rainfall from December to March, the main dry season, is less than 10 mm per month.

The mean annual temperature is 28.4°C **, which is only a few tenths of a degree higher than the mean annual temperature of Bangkok. April is the hottest month (31.2° C average) and December is the coolest month (24.6° C average).

VEGETATION AND LAND USE

Most of the Nakhon Sawan study area is cultivated. Rice is the main crop in the alluvial plains, the lower parts of the semirecent terraces, and the low terraces. Dryland crops, mainly corn, are grown on the higher paneplain, the higher terrace formations, and the footslopes of the hills. Jute, sugarcane, and fruit are grown on the higher parts of the levees where an important part of the villages are situated. Some corn and jute are also grown in rotation with rice on the better drained alluvial soils.

Reeds, rushes and bamboo are widespread in the lower parts of the alluvial plains, especially the area north of the confluence of the Mae Nam Ping and the Mae Nam Nan and the area around Bung Boraphet. Secondary forests and shrub savanna are found scattered throughout the terraces, the peneplains, and the low hills. Some primary forests are found on the higher parts of the hills. Some of the common species are : yang khao (Dipterocarpus alatus), yang daeng (D. costatus), krabak (Anisoptera glabra), payung and ching chan (Dalbergia sp.), ma-ka (Afzelia sp.), takhian (Hopea odorata), kathon (Sandoricum indicum), pradu (Pterocarpus macrocarpus), teak (Tectona grandis), and tabeak (Lagerstroemia calyculata).

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* 1 mm = 0.03937 in.

** °F = 1.8°C + 32

HYDROGRAPHY

The entire study area is drained by the Mae Nam Chao Phraya river system. The water regime of the alluvial plains is controlled by the three main streams; such areas are subject to flooding during the high water stages of these streams at the height of the wet season. Only the main streams flow continuously throughout the year; during the dry season small tributary streams cease to flow and the water level of Bung Boraphet drops considerably.

In recent years the hydrologic regime of the Mae Nam Ping has been modified by the construction of Bhumiphol Dam, midway between Nakhon Sawan and Chiang Mai. Flooding of the lower plains has become less severe and less prolonged, and parts of these areas have been reclaimed for agriculture. The higher plains, the terraces, and the paneplain are not subject to flooding and have a low water table during the dry season; however, low terraces, although not flooded by overflowing streams, are inundated for several months by rain water retained in the rice paddies.

SOIL FORMATION AND PARENT MATERIAL

Transported material

Recent river alluvium. These deposits are usually clayey, but more silty or sandy materials are found in the river levees and in the abandoned streams channels of the alluvial plains. The largest concentration of these sediments is found adjacent to the main streams.

Terrace alluvium and slope colluvium

a. Semirecent terrace river alluvium. These materials are commonly fine textured, but coarser materials are also found. They occur on a slightly higher level then the recent river alluvial deposits and terrace sediments.

b. Low terrace river alluvium. These materials are medium to fine textured; however, some sandy deposits occur. These deposits are found adjacent to the recent and semirecent alluvial sediments.

c. High terrace river alluvium and slope colluvium. These materials are usually strongly leached and have medium to fine textures; however, some sediments are composed of marl and are predominantly fine textured. These latter materials are found in association with limestone. Higher terrace sediments adjacent to the hills and in the peneplain are commonly gravelly.

Residual material

Residuum and colluviated residuum

a. Andesite and rhyolite porphyry. These materials are commonly medium to fine textured and contain varying amounts of rock fragments; they often include materials derived from associated rocks, i.e. limestone, diorite, phyllite, or shale.

b. Granite or granodiorite. These materials are medium textured with a considerable coarse sand fraction, and contain varying amounts of rock fragments.

c. Limestone and associated rocks (quartz phyllite or mica schist). These materials are fine textured and contain considerable amounts of limestone, quartzite phyllite, or mica schist fragments. Iron manganese concretions are often found in deeper layers.

d. Mica schist and associated rocks (quartzite phyllite). These materials are usually medium to fine textured and are normally found in the hills or near rock outcrops. They may contain mica flakes and a variety of rock fragments.

SOIL CLASSIFICATION

In the classification of soils for this study, attention has been given largely to dividing the soils into series. All the soils of one series have profiles almost alike and have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographical feature near the place where the series was first mapped. Where soils differed strongly over short distances, making separation by series difficult, the area was mapped as an association. Soils which represented a relatively small area were surveyed as unnamed units.

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To accomodate minor differences in the texture, pH, mottling, etc., of the various layers, series were sometimes separated into soil phases. Some of these soil phases differ from the modal series in one or two important genetic characteristics, but because of the rare occurrence of these soil phases they were treated as separate phases within the series which they most nearly resembled.

The soils in the Nakhon Sawan study area have been classified by soil series as defined in the U.S. Department of Agriculture Soil Survey Manual (4).

Following the name of each soil series, there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil maps.

For the sake of convenience, the soil survey of the study area has been arranged into three maps which were combined from the following AMS Series L 708 map sheets :

Sheet I - No. 4957-I, 4958-I and -II

Sheet II - No. 5057-IV, 5058-III and-IV

Sheet III - No. 5057-I, 5058-I and -II

Sheet IV is the key and gives the main properties of the various mapping units.

Soil series

Tha Muang (Tm). Tha Muang soils occupy the levees along streams and abandoned stream channels. The main occurrences of these soils are found along the Mae Nam Chao Phraya, Mae Nam Nan, Mae Nam Ping, and Mae Nam Yom.

These soils are well to moderately well drained and are the traditional sites for settlement; vegetable gardens and fruit orchards are commonly found on these soils. In some areas dryland crops such as jute, sugarcane, and corn are grown.

Tha Muang soils are Alluvial * soils with an A-C or Cg horizon sequence. These soils are predominantly sandy loam, or silt loam. Mica is commonly found throughout the profile and is most abundant in the soils adjacent to the Mae Nam Ping. There is an abrupt boundary between the surface layer and the underlying subsoil. Color in the surface is predominantly brown to yellowish brown. Color in the subsoil is dark grayish brown in uncultivated areas and brown to yellowish brown in cultivated areas. Mottling sometimes occurs in the subsoil. Values of pH are medium to slightly acid (5.5 to 6.5).

* Great soil group names are capitalized.

Sapphaya (Sa). Sapphaya soils occur along the river levees in association with Tha Muang soils. Sapphaya soils are similar to the Tha Muang soils in texture and matrix color but are generally somewhat lower in topographic position.

These soils are well to moderately well drained but are usually flooded during the wet season. They are normally used for growing rice.

Sapphaya soils are Alluvial hydromorphic soils with an Apg-Cg horizon sequence. These soils are normally loam to silt loam but occasionally silty clay loam is found below 50-60 cm in depth. The color of these soils when dry is pale brown or very pale brown. Because of their use for growing rice, these soils have acquired a mottled surface (inverted gley) that is concentrated along the root channels. Mica is commonly found throughout the profile. Values of pH are medium to slightly acid (5.5 to 6.5).

Chainat (Cn). Chainat soils occupy the transition zone between the levee and the river basin. They have a flat to slightly undulating topography. They are commonly found adjacent to the Sapphaya and Rat Buri soils and exhibit, to some extent, characteristics of each.

Chainat soils are moderately well to somewhat poorly drained and are mostly used for growing rice. Some dryland crops such as jute and corn are also grown.

Chainat soils are Alluvial hydromorphic soils with an Ag-Cg horizon sequence. These soils are commonly clay loam to silty clay to a depth of 1 m or more; however, a thin layer (10-30 cm depth) of loam or silt loam often occurs at the surface, and a heavy clay, typical of Rat Buri series soil, is sometimes found in the subsoil at a depth of 70-80 cm. Mica is seldom found in these soils. The color of the topsoil is grayish brown, whereas color of the subsoil is predominantly brown but is occasionally yellowish brown. The profile is mottled throughout. Values of pH are strongly acid (5 to 5.5) in the topsoil and medium to slightly acid (5.5 to 6.5) in the subsoil.

Rat Buri (Rb). Rat Buri soils occupy the higher parts of the alluvial plains and are usually found at some distance from the levees and abandoned river channels. They have a flat to slightly undulating topography.

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These soils are subject to flooding during the wet season and are poorly drained. They are used for growing rice and give moderate yields.

Rat Buri soils are Alluvial hydromorphic soils with an Ag-Cg horizon sequence. These soils are usually composed of clay but in some areas a thin clay loam or silty clay loam layer (20-30 cm in depth) occurs. Laterite concretions washed in by floods are often found in the soils east of the Mae Nam Nan and north of the confluence of the Mae Nam Nan and Mae Nam Ping. Color of the surface layers is usually very dark grayish brown (10 YR 3/2) to dark brown (10 YR 3/3); although in some profiles the matrix color is gray. Color in the subsoil varies from grayish brown (10 YR 5/2) to yellowish brown (10 YR 6/6). These soils are mottled throughout the profile. In the surface layer brown to yellowish brown mottles are concentrated along root channels. Values of pH are strongly to slightly acid (5 to 6.5) and increase with depth.

A calcareous phase (Rb-ca) of the Rat Buri series is recognized and indicated on the soil maps. These calcareous phase soils are found in the alluvial plain between the Mae Nam Nan and Mae Nam Ping and were separated from the normal Rat Buri series because of their neutral to alkaline reaction. They occupy slightly lower positions than the normal Rat Buri series and are subject to flooding for longer periods during the wet season. These soils are poorly drained and are usually not cultivated because of their low position and excessive flooding. Bamboo forests are predominant. Rat Buri, calcareous phase soils are composed of clay. Color is very dark brown (10 YR 2/2) to very dark grayish brown (10 YR 3/2) in the surface layers and grayish brown (10 YR 5/2) or light brownish gray (2.5 Y 6/2) in the subsoil. These soils are mottled throughout and always contain limestone fragments. Values of pH are usually slightly acid (6 to 6.5) in the surface layers, but rise in the subsoil.

Phimai (Pm). Phimai soils are found in the abandoned channels (oxbows) and in the lower parts of the river basins. They have a flat topography.

These soils are poorly drained and are subject to flooding each year. The Phimai soils in the river basins are used for growing rice but those in abandoned river channels are not.

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Phimai soile are Alluvial hydromorphic soile with a horizon eequence of Apg-Cg; the Apg horizon is usually well developed and humiferous. Theee soils are composed of heavy clay. Mottling occure throughout the profile. Color of the eurface layer (depth 20 to 30 cm) is dark gray to black, whereae the dominant color of the subsoil ie gray to olive gray (in the Munsell color chart notatione the chroma is ueually one or less). Distinct mottlee, few to common are found in the subsoil. When theee eoile are dry they contain large slickeneides at varying depthe. Valuee of pH are ueually medium to elightly acid (5.5 to 6.5) in the topeoil and neutral (6.5 to 7) in the subsoil.

Yang Pong (Yp). Yang Pong soils occupy depressione and backswampe of river baeine and old river channels of semirecent terracee. A large occurrence of these soils is found around Bung Boraphet. They have a flat topography and a dietinctive microrelief. Those Yang Pong eoils which form on the eemirecent terracee are aeeociated with Kamphaeng Saen complex soile.

Yang Pong eoils are continuouely saturated with water and are rarely cultivated. Some lotus ie grown on the higher parts of theee eoile but marehy vegetation generally predominatee.

Yang Pong soile are Alluvial hydromorphic soils with an Ag-Cg horizon eequence. They are composed of heavy clay and have a dark humiferous eurface horizon. Reduced, bluieh to gray eoil layere occur at a shallow depth. Valuee of pH are strongly to slightly acid (5 to 6.5).

Chum Saeng (Ce). Chum Saeng soile are found extensively in the alluvial plaine east of the Mae Nam Nan. These eoils are eimilar to the Manorom eeriee but occupy a lower position on the alluvial plain and have a weaker profile development and no termite mounds. They have a flat topography.

Theee eoile are poorly drained and subject to flooding during the wet seaeon. They are ueually used for growing rice and give moderate yields.

Chum Saeng soils are Alluvial hydromorphic eoile with an Apg-Cg horizon sequence. These soile are compoeed of clay to a depth of 1 m or more. Matrix color is dark gray (10 YR 4/1) to grayish brown (10 YR 5/2) in the eurface layere and pinkish gray (7.5 YR 6/2) to gray (10 YR 6/1) in the subsoil. Theee eoils are mottled throughout; brown (10 YR 5/3) to yellowish brown (10 YR 6/8) mottles are concentrated along the

root channels in the surface layers and fine to medium, strong, red mottles (2.5 YR hue or below) occur below a depth of 20 to 30 cm. Values of pH are very strongly to strongly acid (4.5 to 5.5).

Tha Tako (To). Tha Tako soils are found along narrow alluvial valleys in the eastern part of the study area where streams cut through the hills and the peneplain. These soils are mainly formed of alluvium deposited by the streams, but near the foot-slopes of the hills they are intermixed with colluvial deposits washed down from the hills. They have a flat to slightly undulating topography and are used for growing rice.

Tha Tako soils are Alluvial and Humic Gley soils with a common horizon sequence of Ag-Cg. These soils are composed mainly of clay but loam is occasionally found in the surface layers to a depth of 20 to 50 cm. Limestone fragments and secondary concretions are usually found in the deeper subsoil, below 50 cm in depth. Matrix color is dark reddish brown (5 YR 3/3) to dark brown (10 YR 3/3) in the topsoil and dark grayish brown to olive brown in the subsoil. Values of pH are normally neutral to mildly alkaline (7 to 8); however, near Chum Saeng a very dark gray clay with a pH value of 5.5 is found in the surface above an olive brown clay subsoil with a pH value of 7 to 8.

Sara Buri (Sb). Sara Buri soils occur in the semi-recent terraces and the transition zone between the semirecent terrace and the recent alluvial plains. Sara Buri soils are similar to Rat Buri soils but occupy slightly higher positions and support termite mounds. They have a flat to slightly undulating topography.

These soils are poorly drained and the lower members are sometimes flooded during exceptionally high floods. The soils are used mostly for growing rice and give moderate yields.

Sara Buri soils are weakly developed Low-Humic Gley soils with an Apg-Btg horizon sequence. These soils are predominantly clay throughout the profile; however, some profiles have a clay loam surface layer and a clay or heavy clay subsoil below 20 cm in depth. Color is very dark gray to dark grayish brown (10 YR 3/1, 10 YR 3/2, 10 YR 4/2) in the surface layer and dark brown or yellowish brown (10 YR 4/3, 10 YR 5/4) below a depth of 15 to 20 cm. Brown to yellowish brown mottling can be observed throughout the profile. When dry, distinctive cracks occasionally appear at the surface.

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Limestone fragments and unconsolidated laterite concretions sometimes occur in the subsoil. Values of pH are strongly acid (5 to 5.5) at the surface and medium acid to neutral (5.5 to 7) in the subsoil.

Nakhon Pathom (Np). Nakhon Pathom soils occur on the lowest parts of the semirecent terraces and occupy abandoned river channels and oxbows. These soils are found in the western part of the study area. They have a flat to slightly undulating topography.

These soils are somewhat poor to poorly drained and the lower members are occasionally subject to flooding during the wet season. Most of these soils are used for growing rice and give good yields during normal rainfall conditions.

Nakhon Pathom soils are Low-Humic Gley soils with an Apg-Btg horizon sequence. These soils are generally composed of clay loam in the surface layers (15 to 20 cm depth) and clay loam to clay in the subsoil. Occasionally, sandy loam to loamy sand is found in the subsoil below a depth of 50 cm. Mica is unique to the Nakhon Pathom soils found in this study area since it usually is not found in these soils in other parts of Thailand. Matrix color is dark grayish brown to dark brown (10 YR 4/4 to 10 YR 6/4) in the topsoil, and very dark grayish brown or yellowish brown in the subsoil. Brown to yellowish brown mottling occurs throughout the profile. Values of pH are strongly acid (5 to 5.5) at the surface and neutral (6.5 to 7) in the subsoil.

An acid phase (Np-a) of the Nakhon Pathom series is recognized and indicated on the soil maps. These soils are similar to the normal Nakhon Pathom soils, but their subsoil pH to a depth of 100 cm or more remain low (4.5-5). In this respect they are similar to Manorom Soils, but they miss the distinct reddish subsoil mottling of the latter.

Phet Buri (Pb). Phet Buri soils are found on levees in the semirecent terraces west of the Mae Nam Ping and are very similar to Kamphaeng Saen soils in topography, color, and texture, but unlike the Kamphaeng Saen soils, the Phet Buri soils are used for growing rice. Only a few small occurrences of these soils are found within the study area. Phet Buri soils have a slightly lower topographic position than the Kamphaeng Saen soils and have a flat to slightly undulating topography.

These soils are moderately well drained and are seldom flooded. They are cultivated and used for growing rice and give moderate yields under normal rainfall conditions.

Phet Buri soils are Low-Humic Gley soils with an Apg-Btg horizon sequence. These soils are composed of fine sandy loam throughout the profile. The color or the surface layer is dark grayish brown (10 YR 4/2) to grayish brown (10YR5/2) but becomes whitish when dry. The color in the subsoil is brown (10YR5/3) to yellowish brown (10YR5/6). Mottling and mica occur throughout the profile. Values of pH are strongly to slightly acid (5 to 6.5), increasing slightly in the subsoil.

Kamphaeng Saen (Ks). Kamphaeng Saen soils occupy the semirecent river levees along former river courses are found in the central and western parts of the study area. These soils are old enough for weathering and the formation of genetic soil horizons to have taken place; genetic horizon development varies according to the texture and age of the levee. The characteristics of these soils are similar to the Tha Muang soils. The Kamphaeng Saen soils have a flat to slightly undulating topography.

These soils are well to moderately well drained and are seldom flooded. They are excellent agricultural soils (both chemically and physically) and are used for growing corn, sugarcane, and jute. Small shrubs and some rubber trees are found on the uncultivated soils.

Kamphaeng Saen soils are Noncalcic Brown soils with a common horizon sequence of A-Bt or A-Btg. These soils are usually composed of fine sandy loam to clay loam, but near the stream channels they are sometimes medium textured or even sandy throughout. The color is dark grayish brown to dark brown (7.5 YR 3/2 to 10 YR 4/2) in the surface layer and brown to yellowish brown (7.5 YR and 10 YR hues) in the subsoil. Weak mottling is occasionally found in the subsoil at depths below 50 cm. These soils always contain mica throughout the profile to a depth of 1 m or more. Values of pH are strongly to slightly acid (5 to 6.5) and increase slightly with depth.

A mottled phase (Ks-mo) of the Kamphaeng Saen series is recognized and indicated on the soil maps. These soils are found in one area east of the Mae Nam Ping near Ban Maha Pho. The mottled phase soils occupy somewhat lower positions than the normal Kamphaeng Saen soils and have a darker colored topsoil and a mottled subsoil. The mottled phase soils are somewhat poorly drained, and most of them are used for growing sugarcane. Small shrubs dominate the uncultivated portions. Generally, these mottled phase soils are composed of loam in the surface layers and clay loam in the subsoil. They are occasionally composed of loam throughout, and sandy materials are also often found below the loam layer in the subsoil at depths of more than 50 cm. Matrix color is very dark gray (10 YR 3/1) to dark gray (10 YR 4/1) to a depth of 20 to 50 cm and grayish brown (10 YR 5/2) to brown (10 YR 5/3) below that depth. Indistinct mottling and mica occur throughout the profile. The pH value is 6 to 6.5 at the surface and falls to 5 or 5.5 in the subsoil.

A leached phase (Ks-l) of the Kamphaeng Saen series is recognized and indicated on the soil maps. These soils are separated from the normal Kamphaeng Saen soils because of their coarse-textured, strongly-leached surface with characteristics intergrading toward Gray Podzolic soils. These soils are excessively drained. The textural profile is the main diagnostic characteristic of the Kamphaeng Saen, leached phase soils. These leached phase soils are composed of loamy sand. Mica is present throughout the profile. Matrix color is very dark gray (10 YR 3/1) to dark grayish brown (10 YR 4/2) in the surface layers (20 to 30 cm depth) and becomes whitish when dry, and grayish brown (10 YR 5/2) to brown (10 YR 5/3) in the subsoil. Values of pH vary due to the poor buffering capacity of the sandy materials but are usually strongly to medium acid (5 to 6).

Krok Phra (Kr). Krok Phra soils are found on the lower parts of the semirecent terraces and occupy slightly higher positions than the Nakhon Pathom soils. Occurrences of these soils are found scattered throughout the western part of the study area. The characteristics of these soils are similar to the Lampang series in the surface layers and the Nakhon Pathom series in the subsoil. Krok Phra soils have a flat to slightly undulating topography.

These soils are somewhat poorly drained and are extensively used for growing rice under irrigation and yields are good.

Krok Phra soils are Low-Humic Gley soils with an Ag-Btg horizon sequence. These soils are composed of loamy sand to sandy loam in the surface layers (approximately 20 to 50 cm depth) and clay loam to clay in the subsoil. Loamy sand or sandy loam textures are occasionally found throughout the profile to a depth of 1 m or more. Mica is often found in the surface layers and is more abundant in the sandy profiles. The color is dark gray (10 YR 4/1) to brownish gray (10 YR 6/2) in the topsoil and grayish brown (10 YR 5/2) to brown (10 YR 5/3) in the subsoil. Yellowish-brown (10 YR 5/6) to brown (7.5 YR 5/4) mottling occurs throughout the profile and is somewhat concentrated along the root channels in the surface layers. Values of pH are strongly acid (5 to 6.5) in the surface and neutral (6.5 to 7) in the subsoil.

Ubon (Ub). Ubon soils occupy semirecent remnants which are found outcropping in the alluvial plains between the Mae Nam Nan and Mae Nam Ping. These soils are somewhat similar to the San Pa Tong, sandy phase and Kamphaeng Saen, leached phase soils. Ubon soils have a flat to slightly undulating topography.

These soils are somewhat poorly drained and are occasionally subjected to flooding during the wet season. Ubon soils are mainly used for growing rice but their low fertility associated with their sandy texture imposes some limitations. Small shrubs are predominant in the uncultivated areas.

Ubon soils are Low-Humic Gley soils with a common horizon sequence of Ag-Btg. A diagnostic characteristic of the Ubon series is its texture which is loam sand or sand. Matrix color is dark gray (10 YR 3/1) to dark grayish brown (10 YR 4/1) in the surface and brown (10 YR 5/3) to light yellowish brown (10 YR 6/4) in the subsoil. These soils are mottled throughout. Values of pH are variable due to the low buffering capacity of their sandy material, but are usually very strongly to strongly acid (4.5 to 5.5).

Manorom (Mn). Manorom soils are found on the semirecent terraces and occupy an extensive portion of the easternmost part of the study area. They have a flat to slightly undulating topography and are occupied by numerous termite mounds.

These soils are somewhat poorly drained and are usually cultivated in rice; yields are moderate under normal rainfall conditions. Groundnuts (peanuts) are grown on some soils, but yields are poor due to the heavy texture of the subsoil.

Manorom soils are Low-Humic Gley soils with an Ag-Btg horizon sequence. These soils are composed of clay loam in the surface layers (between 15 and 40 cm in depth)and clay or heavy clay in the subsoil. Occasionally, loam or fine sandy loam is found in the surface layers. Matrix color of the top soil is dark gray (10 YR 4/1) to grayish brown (10 YR 5/2) but becomes whitish when dry in some profiles. Color in the subsoil is gray (10 YR 6/1) to light brownish gray (10 YR 6/2). Most of these soils have a granular mulch in a thin layer at the surface as a result of wetting and drying. Manorom soils are mottled throughout. Brown (10 YR 5/3) to yellowish brown (10 YR 5/8) indistinct mottling is concentrated along root channels in the surface layers, whereas very distinct red mottling (2.5 YR or less) is found at depths from 20 to 50 cm. Scattered lateritic gravel is often found in the profiles at varying depths. Values of pH, which are somewhat higher in the surface layer than in the subsoil, are very strongly to strongly acid (4.5 to 5.5).

Boraphet (Bo). Boraphet soils occupy an elongated area on the semirecent terrace between the peneplain and the alluvial plains southeast of Bung Boraphet. They have a flat to slightly undulating topography.

These soils are poorly drained and are mainly used for dryland crop cultivation; corn and beans are the main crops. Uncultivated areas are overgrown with bamboo forests or grass.

Boraphet soils are Humic Gley soils with an Ag-Bg or Cg horizon sequence. These soils are composed of clay and are very sticky when wet. The surface layer (20 to 40 cm depth) is black (10 YR 2/1) to very dark grayish brown (10 YR 3/2) with indistinct mottling, and the subsoil is grayish brown (10 YR 5/2) to gray (10 YR 6/1). Distinct strong red mottling (2.5 YR or below) occurs in the subsoil. In some areas the dark surface layer has been removed by erosion thereby exposing the grayish clay subsoil with the strong red mottling. Values of pH are slightly acid to neutral (6 to 7) or moderately alkaline (8) in the surface and very strongly to strongly acid (4.5 to 5.5) in the subsoil.

Lampang (Lp). Lampang soils are found on the low terraces and occupy a large portion of the western part of the study area; smaller areas are also found in the southeastern part of the study area. Lampang soils usually have a flat to slightly undulating topography.

These soils are somewhat poorly drained and are saturated or partly inundated during the wet season. They are used exclusively for growing rice and bear medium yields under normal rainfall conditions.

Lampang soils are Low Humic Gley soils with a common horizon sequence of Ag-B. These soils are composed of loamy sand to sandy loam in the surface layers and sandy loam to sandy clay loam in the subsoil. Clay or heavy clay is occasionally found below a depth of 70 cm and some profiles are sandy loam throughout. Matrix color is dark grayish brown (10 YR 4/2) to grayish brown (10 YR 5/2) in the surface layer, which is poor in organic matter, and grayish brown (10 YR 5/2) to light brownish gray (10 YR 6/2) in the subsoil; however, a brownish (10 YR 4/3 or 10 YR 6/4) color is also sometimes found in the subsoil. Brown to reddish mottling occurs throughout the profile and becomes redder in profiles with a clayey subsoil. Values of pH are usually very strongly to strongly acid (4.5 to 5.5) but are sometimes slightly acid to neutral (6 to 7) in the subsoil.

A clayey phase (Lp-cl) of the Lamphang series is recgonized and indicated on the soil maps. The clayey phase soils are separated from the normal Lampang series because of a heavy clay layer in the subsoil and the presence of strong, red mottling. These soils consist of heavy clay at depths between 20 and 50 cm. Matrix color is dark grayish brown (10 YR 4/2) to grayish brown (10 YR 5/2) in the surface and gray (10 YR 6/1 or 10 YR 5/1) to grayish brown (10 YR 5/2) in the subsoil. Mottling in the surface layer is brown (10 YR 5/3) to yellowish brown (10 YR 5/8) and is concentrated along the root channels. In the heavy clay layer strong red mottling (2.5 YR hue or below) occurs and concretions are occasionally found. Other characteristics are similar to the normal Lampang soils.

A concretionary phase (Lp-cc) of the Lampang series is recognized and indicated on the soil maps. These soils contain a considerable amount of lateritic concretions in the subsoil, usually below 50 cm. The density of the laterite is, however not sufficient, nor does it occur shallow enough to classify such soils with the Sakon or Phen series. In all other characteristics these soils are comparable with modal Lampang soils.

Sakon (Sk). Sakon soils occur on the low terrace and on the colluvial footslopes of andesite and rhyolite hills and are found in the southeastern part of the study area. They have a slightly undulating to undulating topography.

These soils are somewhat well to somewhat poorly drained. Rice and dryland crops are cultivatdd on the soils which are more than 30 cm thick. Soils with laterite at or near the surface are not cultivated and are overgrown with small shrubs.

Sakon soils are Low-Humic Gley soils that intergrade with Gray Podzolic soils. These soils have an A-Bt or Ag-Btg horizon sequence and usually consist of dark grayish brown (10 YR 4/2) to brown (10 YR 5/3) sandy loam to clay loam above a hard laterite. The diagnostic characteristic of these soils is presence of consolidated laterite in block or sheet form (20 cm or more in thickness) at depths of less than 50 cm. The laterite is occasionally found in spots at the surface but generally it is covered by a thin layer of soil between 25 and 40 cm in depth. Soils which are used for growing rice are mottled. Values of pH are very strongly to medium acid (4.5 to 6).

San Pa Tong (Sp). San Pa Tbng soils which occupy the low terraces composed of old river alluvium and some slope colluvium, are found almost exclusively in the western part of the study area. They have a flat to slightly undulating topography.

These soils are well to moderately well drained and are mainly uncultivated. Some soils are used for growing corn. Sparse low shrubs are dominant in uncultivated areas; however, patches of barren ground also occur.

San Pa Tong soils are Gray Podzolic soils with a common horizon sequence of A1-A2-Bt or Ap-Bt. The textural B horizon is weakly expressed, especially when the soil is developed on sandy textured sediments. These soils are composed of loamy sand to sandy loam on the surface and sandy loam to sandy clay loam in the subsoil. Color of the surface layer is very dark grayish brown (10 YR 4/2) to dark brown (10 YR 3/3 or 7.5 YR 4/2 - 4/4) and becomes light gray (10 YR 26/1) to pale brown (10 YR 6/3) when dry. The color of the subsoil is reddish yellow (5 YR 6/6) to brown (10 YR 3/3). Mottling sometimes develops in the lower part of the profile (between 70 to 80 cm in depth). Values of pH are medium acid (5.5 to 6) in the surface and strongly acid (5 to ~.5) in the subsoil.

A colluvial phase (Sp-col) of the San Pa Tong series is recognized and indicated on the soil maps. These colluvial phase soils are composed mainly of coarse colluvial material occurring around acid igneous rocks and resistant limestone hills. San Pa Tong, colluvial phase soils are composed of loamy sand in the surface layer and sandy loam or sandy clay loam in the subsoil. Occasionally, loamy sand with medium to coarse colluvial fragments is found throughout the profile. Matrix color is dark reddish brown (5 YR 3/3) to grayish brown (10 YR 5/2) in the surface layers and brown (10 YR 5/3) to very pale brown (10 YR 7/4) in the subsoil. Mottling develops only in the lower parts of the profile. Values of pH are normally strongly to medium acid (5 to 6); however, in sandy profiles the pH may be 7 to 8 in the surface layers or throughout the profile.

A sandy phase (Sp-s) of the San Pa Tong series is recognized and indicated on the soil maps. These soils are found on the low terraces and in the transition zone between the high and low terraces and are similar to the Kamphaeng Saen, leached phase soils (but do not contain mica). Some soils occupy old levee-like remnants. The San Pa Tong, sandy phase soils are composed of loamy sand throughout the profile. Color is dark gray (10 YR 4/1) to grayish brown (10 YR 5/2) in the surface (15 to 25 cm depth) and brown (10 YR 5/3) to pale brown (10 YR 6/3) in the subsoil. Values of pH are normally strongly to slightly acid (5 to 6.5).

Lat Ya (Ly). Lat Ya soils occupy the high terraces and some colluvial footslopes of hills and occur mainly in one relatively small area along the western border of the study area near Ban Bung Lom. Occurrences of these soils were also found on the peneplain and were included with other soils in an Unnamed Complex due to the complexity of the parent rock. Lat Ya soils have a slightly undulating to undulating topography.

Most of these soils are overgrown with forests or scattered shrubs. Shifting cultivation is practiced on some soils and kapok plantations are occasionally found.

Lat Ya soils are Red-Yellow Podzolic soils with an A-Bt horizon sequence. These soils are predominantly coarse sandy loam throughout the profile; however, some profiles have sandy clay loam in the subsoil. Gravel is commonly present below a depth of 50 cm in those which are found on the peneplain.

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Matrix color is reddish brown (5 YR 4/4) to strong brown (7.5 YR 5/6) in the surface (slightly darker in forested soils) and yellowish red (5 YR 4/6) to strong brown (7.5 YR 5/6)in the subsoil. Values of pH are normally very strongly to strongly acid (4.5 to 5.5); however,values of 7 to 8 are found in the peneplain where Lat Ya soils are mixed with limestone.

Lop Buri (Lp). Lop Buri soils are found on the lower parts of the peneplain located in the southeastern part of the study area, and are formed on alluvium derived from limestone. These soils are somewhat lower and more hydromorphic than the Pak Chong and Takli soils. They have a flat to slightly undulating topography.

Most of the Lop Buri soils are overgrown with bamboo and shrubs. Some corn grown in the higher areas, and rice is sometimes grown in the lower areas.

Lop Buri soils are Black Grumosols with an indistinct A-Cg or Ag-Cg horizon sequence. These soils are generally composed of heavy clay of the montmorillonitic type. Lop Buri soils are very sticky and plastic and tend to swell when wet. When dry, they become hard and crack deeply. Self mulching characteristics at the surface and the presence of slickensides at varying depths in the soil are characteristic of this series. Matrix color is black (10 YR 2/1) to dark gray (10 YR 4/1)in the surface layer (20 to 40 cm in depth) and gray (10 YR 5/1) or grayish brown (10 YR 5/2) in the subsoil. Indistinct mottling occurs throughout the profile. Fine to coarse colluvial fragments and limestone fragments (below 80 cm in depth) are commonly found in many profiles. Values of pH are neutral to mildly alkaline (7 to 8).

Takli (Tk). Takli soils are found on the peneplain in the southeastern part of the study area and also occupy a small portion of a low terrace in the western part of the study area north of Ban Don Khwang. Some of these soils are found as residual remnants and form isolated "islands" surrounded by old river deposits. Takli soils have an undulating topography.

These soils are somewhat poorly drained and most of them are covered with sparse low shrubs and bamboo forests. Corn is grown on some of the higher areas and rice is grown on some of the lower areas.

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Takli soils are primarily Rendzina soils with an A-C or A-(B)-C horizon sequence, but a few are Brown Forest soils. Takli soils are composed of clay. Matrix color is very dark gray to gray (10 YR 3/1 to 10 YR 5/1) in the surface layer (approximately 30 cm in depth). A whitish, soft limestone occurs at varying depths in the subsoil. In some soils hard limestone is encountered below a depth of 40 to 50 cm. Takli soils have a high base saturation and are very sticky when wet; self-mulching characteristics are present at the surface. Values of pH are neutral to mildly alkaline (7 to 8).

Pak Chong (Pc). Pak Chong soils are found in the peneplain and on some colluvial slopes adjacent to the limestone and predominantly andesite hills which are located south and southeast of Nakhon Sawan. Pak Chong soils are Red Brown Earths that intergrade with Brown Forest soils. These soils have a common horizon sequence of A1 (Ap)-A3-Bt. or A-Bt; the A1 (Ap) horizon seldom exceeds 20 cm in depth. Consistence is hard in the topsoil and firm in the subsoil when dry, and sticky and plastic when wet.

All Pak Chong soils within the study area were subdivided into two phases, a colluvial phase and a shallow dark phase. The modal Pak Chong soils, surveyed in the Lop Buri study area (app. B) do not occur here. Occurrences of these two phase are indicated on the soil maps and the important characteristics of each phase are described below:

- Pak Chong, colluvial phase (Pc-col) soils are formed on colluviated residuum from the limestone hills and occupy only a small area along the southern edge of the study area. They have an undulating to rolling topography.

These soils are moderately well to well drained and are generally not cultivated. They are usually overgrown with small shrubs. Corn is grown on the few soils which are cultivated.

Pak Chong, colluvial phase soils are composed of clay loam in the surface and clay in the subsoil. Matrix color is dark reddish brown (2.5 YR 3/4) to reddish brown (5 YR 4/4) in the surface layers and red (2.5 YR 4/6) to yellowish red (5 YR 4/6) in the subsoil. Light olive brown mottling is occasionally found in the subsoil at depths below 40 cm. Colluvial fragments composed of limestone and other basic materials occur throughout these soils and increase in size with depth. Values of pH are neutral to mildly alkaline (7 to 8) in the surface and slightly acid (6 to 6.5) in the subsoil.

- Pak Chong, shallow dark phase (Pc-sd) soils are found on the peneplain southeast of Nakhon Sawan. They have a slightly undulating to undulating topography.

These soils are well to moderately well drained and are mainly used for dryland cultivation; corn and castor beans are the main crops. Bamboo and small shrubs are scattered throughout the uncultivated areas.

Pak Chong, shallow dark phase soils are composed of clay. Matrix color is very dark gray (5 YR 3/1) to dark grayish brown (5 YR 3/2) in the surface layer and dark reddish brown (5 YR 3/4) or reddish brown (5 YR 5/4 or 5/3) in the subsoil. These soils generally contain limestone fragments at depths below 50 to 70 cm. Values of pH are neutral to mildly alkaline (7 to 8).

Nakhon Sawan (Ns). Nakhon Sawan soils occupy areas adjacent to the mica schist and limestone hills sutth of Nakhon Sawan. These soils are composed of colluviated residuum derived primarily from mica schist but also from limestone, shale, and quartzite. They have an undulating to rolling topography. Nakhon Sawan soils also occur in association with Tha Yang soils.

These soils are well drained and are mainly overgrown with low shrubs and bamboo. Some dryland crops, mainly corn, are grown on the more moderately drained soils.

Nakhon Sawan soils are Reddish-Brown Lateritic soils that intergrade to Red Brown Earths. The common horizon sequence is A-Bt. The soils are composed of loam in the surface (15 to 20 cm depth) and clay loam in the subsoil; some profiles are composed of clay loam throughout. Colluvial gravel is usually found in the deeper subsoil below approximately 60 cm. The color of the surface layer is dark reddish brown (2.5 YR 3/4) to dark brown (5 YR 3/2). Matrix color in the subsoil is dark red (2.5 YR 3/6) or yellowish red (5 YR 4/6). Values of pH vary locally from medium acid to neutral (5.5 to 7).

Li (Li). Li soils are found on colluviatdd residuum derived from shale, phyllite, and andesite and occur only in one small area surrounding Khao Samuk (hill) east of Lat Yao. They have an undulating to rolling topography.

Li soils are well drained. Vegetatile gardens and fruit orchards abound on these soils.

Li soils are Reddish-Brown Lateritic soils with an A-Bt horizon sequence. These soils are composed of clay loam in the surface layer (30 to 40 cm depth) and clay in the subsoil. Colluvial fragments and lateritic concretions are found throughout the profile, but are more concentrated in the subsoil at depths below 70 cm. The deeper subsoil is often resistant to auger penetration. Matrix color is yellowish red (5 YR 4/6) in the surface layer and red (10 R 4/6) in the subsoil. The pH is commonly slightly acid (6.5).

Tha Yang (Ty). Tha Yang soils are shallow soils on stony colluvium and residuum from acidic rocks and occupy low hills and knolls (with a slope of less than 15 percent) in the southeastern part of the study area. They usually have a rolling topography.

Most of these soils are uncultivated because of their shallow depth and stony character. Dryland crops (corn and castor beans) are grown only where deeper soils are found. Small shrubs and bamboo are the dominant vegetation on the uncultivated soils.

Tha Yang soils are predominantly Red-Yellow Podzolic soils, (occasionally, Lithosols are included in this series) with an A-Bt or A-C horizon sequence. These soils are composed of gravelly sandy loam at the surface and gravelly sandy clay loam in the subsoil; numerous rock fragments are found at less than 50 cm in depth. These soils are usually covered with thin layers of gravelly soil material to depths between 20 and 40 cm. Value of pH is usually very strongly to strongly acid (4.5 to 5.5); however, values of 7 to 8 in the subsoil are occasionally found in those soils which are mixed with limestone.

OTHER MAPPING UNITS

Associations

Kamphaeng Saen and Phet Buri(Ks/Pb). This association covers an area of mainly composed of Kamphaeng Saen soils, with scattered patches of Phet Buri soils under rice. The topography is slightly undulating; the Phet Buri soils are situated in the relatively low parts of the area. Kamphaeng Saen soils are under uplandcrops and shrubs.

Lampang and San Pa Tong (Lp/Sp). This association consists of higher "islands" of San Pa Tong soils surrounded by lower Lampang soils. The topography is flat to slightly undulating. San Pa Tong soils are overgrown with forests and scattered shrubs. The Lampang soils are used for growing rice.

Tha Yang and Nakhon Sawan (Ty/Ns). This association is found on the footslopes of the mica schist and limestone hills south of Nakhon Sawan and consists mainly of Tha Yang soils. The topography is undulating. These areas are of little agricultural value as most soils are shallow and stony, although some dryland crops are grown on Nakhon Sawan soils.

Complex soils

Unnamed complex (Uc). This unit consists of Tha Yang, Lat Ya, Takli, Pak Chong, shallow dark phase, Nakhon Sawan, and a topographically high variant of Lampang soils occurring in a complex pattern of areas which are too small to be mapped individually. These soils are found on the peneplain southeast of Nakhon Sawan and have an undulating topography with distinct microrelief features. These soils have a complex intergrated pattern of rock types. Dryland crops (mainly corn) are grown on the dryer soils with higher elevations and rice is grown on the hydromorphic soils. Small shrubs and grasses are predominant in other areas.

Alluvial complex (Ac). This unit (unnamed) is composed mainly of Tha Muang, Sapphaya, Chainat, Rat Buri, Phimai, and Yang Pong soils occurring in association with eahh other in areas which are too small to be mapped separately. This complex is almost exclusively found in the alluvial plains between the Mae Nam Nan and Mae Nam Ping and west of the Mae Nam Chao Phraya. The river levees and abandoned stream channels in these areas create a strong microrelief. Alluvial complex soils are usually not cultivated; however, in some areas rice and vegetatbles are grown. Marsh vegetation and a few small shrubs are dominant.

Slope complex (Sc). This unit consists of a complex of unnamed soils on steep slopes of the hills. They are predominantly shallow, stony, Red-Yellow Podzolic soils, Reddish-Brown Lateritic soils, Red-Brown Earths, Brown Forest soils and Lithosols. Forests of various types are predominant throughout this unit.

Subdivisions have been made according to the parent material as follows:

Sc-li soils are found on craggy hills of hard limestone with many rock outcrops. These soils are asociated with Pak Chong soils.

Sc-an soils are formed on rounded hills of andesite and rhyolite porphyry with few rock outcrops. They are mainly associated with Pak Chong soils.

Sc-ms soils are formed on low rounded hills of mica schist and associated rocks with few rock outcrops. They are associated with Nakhon Sawan soils.

Sc-ai soils are formed on acid igneous rocks, mainly granodiorite, granite, or diorite. They form rounded hills with few rock outcrops and are associated mainly with Tha Yang soils.

Sc-ms-li (bi) soils are found on rounded hills of complex rocks, mainly mica schist with limestone, and some basic intrusions. There are few rock outcrops. These soils are associated with Pak Chong and Nakhon Sawan soils.

Kamphaeng Saen Complex (Ks-c). This unit is composed mainly of Kamphaeng Saen, leabhed phase, Nakhon Pathom, Phet Buri, Phimai, and Yang Pong soils. It is a complex of soils of old river levees and abandoned channels in the semirecent terraces. They occur in east-west strips, beginning south of Lat Yao and passing north of Khao Luang hill range to the alluvial plains of the Mae Nam Ping. Only the lower members of this unit are subject to flooding. Dryland crops are grown on these soils outside the depressions; rice is grown on these soils in some depressions whereas others are abandoned to marshy vegetation.

S-52

LITERATURE CITED

1. Pendleton, R.L., Thailand, American Geographical Society Handbook, Duell, Sloan, and Pearce Co., New York (1962).

2. Brown, G.F, et al, "Geological Reconnaissance of the Mineral Deposits of Thailand," U.S. Geographic Survey Bulletin No 894, Washington, D.C. (1951).

3. Types of Forest in Thailand. Handbook R44. Royal Forestry Department, Ministry of Agriculture, Bangkok, Thailand (1962).

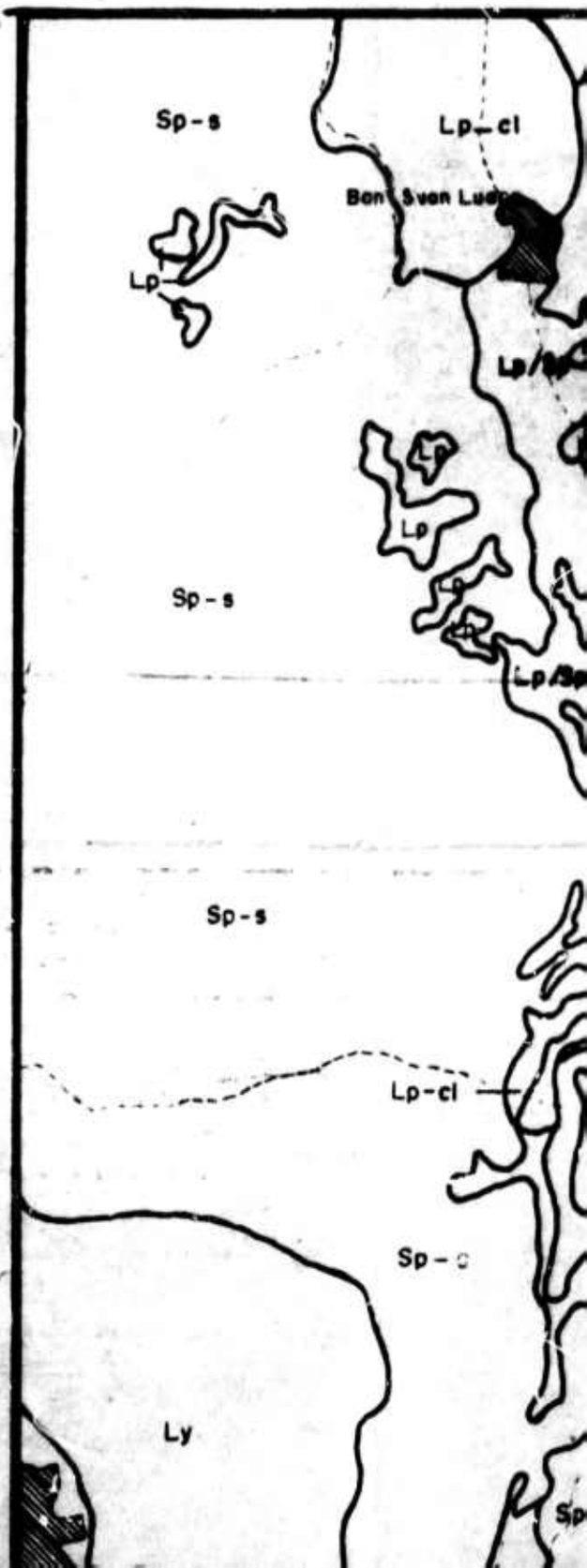
4. U.S. Department of Agriculture Handbook No. 18, Soil Survey Manual (August 1951).

99°45

15°55

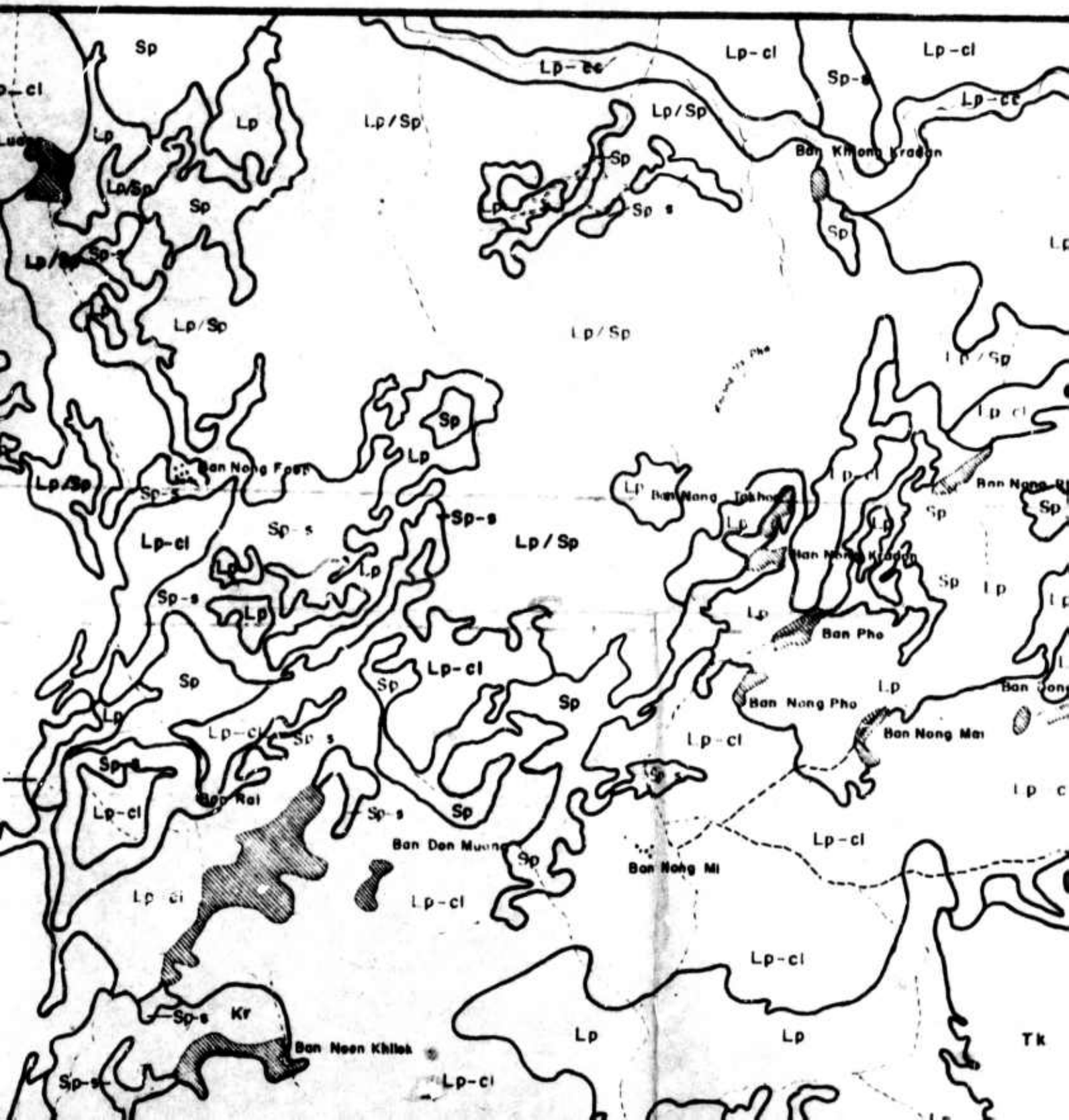
15°50

scale 1:50,000



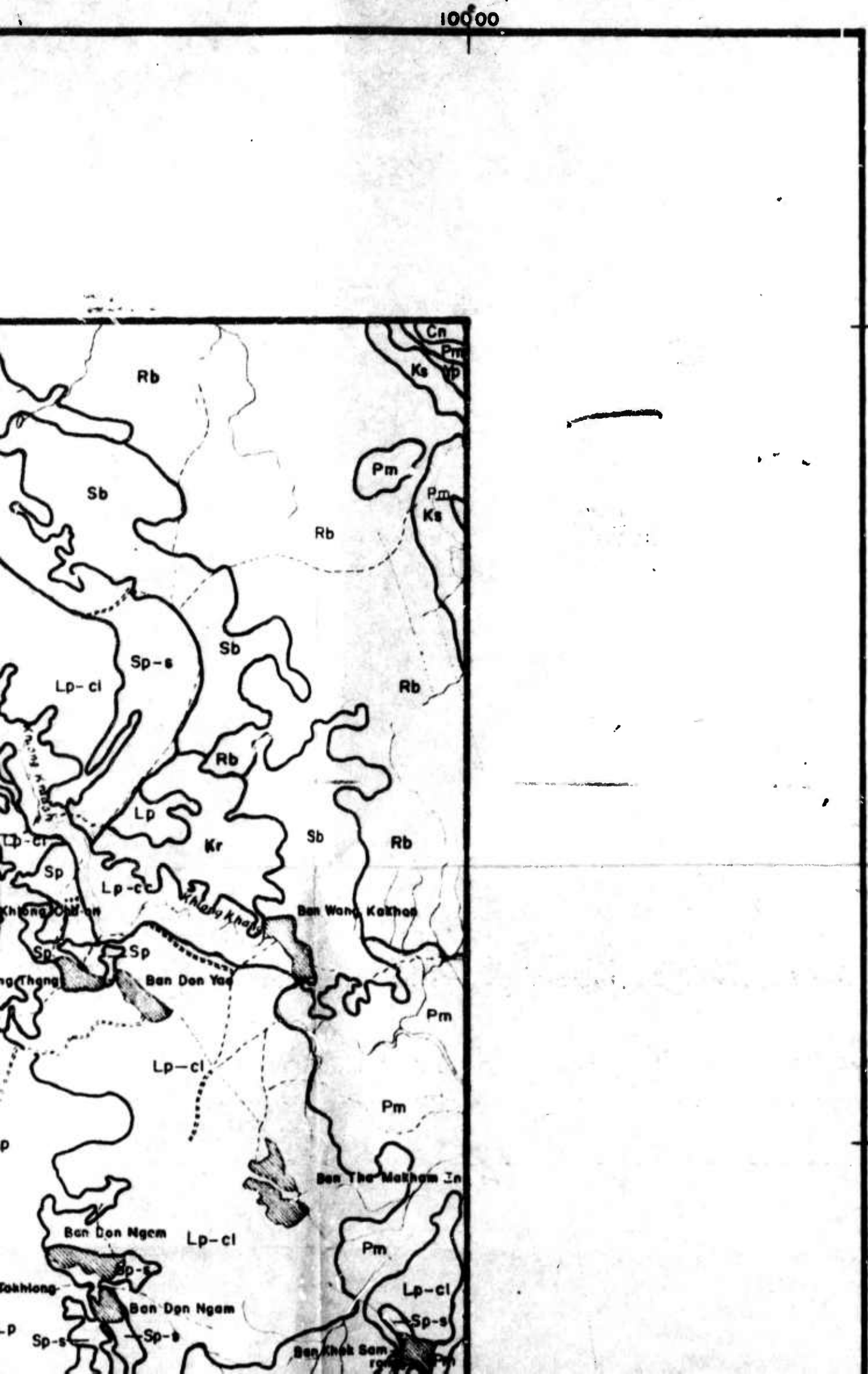
99°30

๒

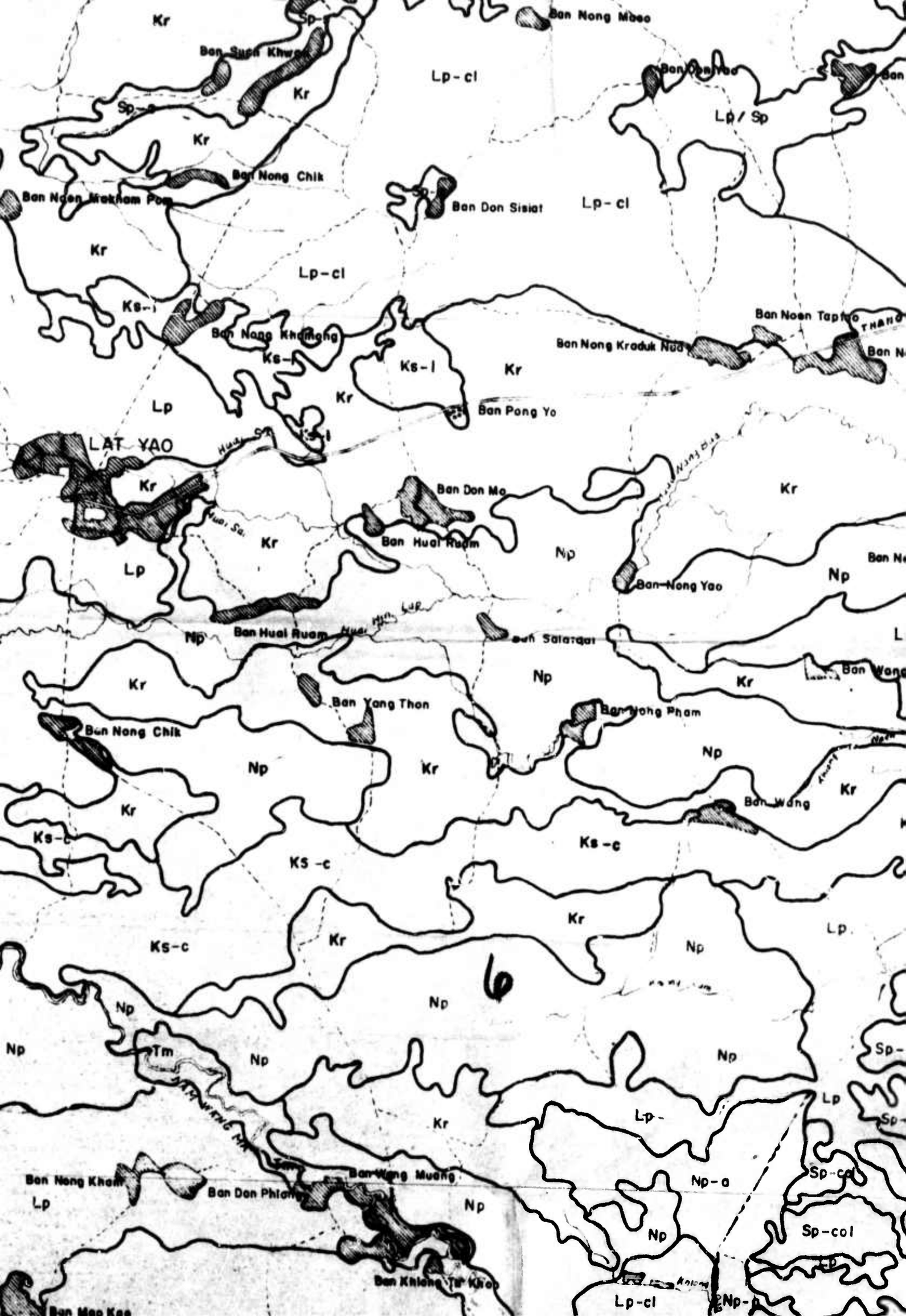

Sp
Lp-cl
Lp
Lp/Sp
Sp-s
Ban Khong Kradan
Ban Nong Faep
Ban Nong
Ban Nong Pho
Ban Nong Mai
Ban Pho
Ban Nong Mi
Ban Noen Khilek
Kr
Tk

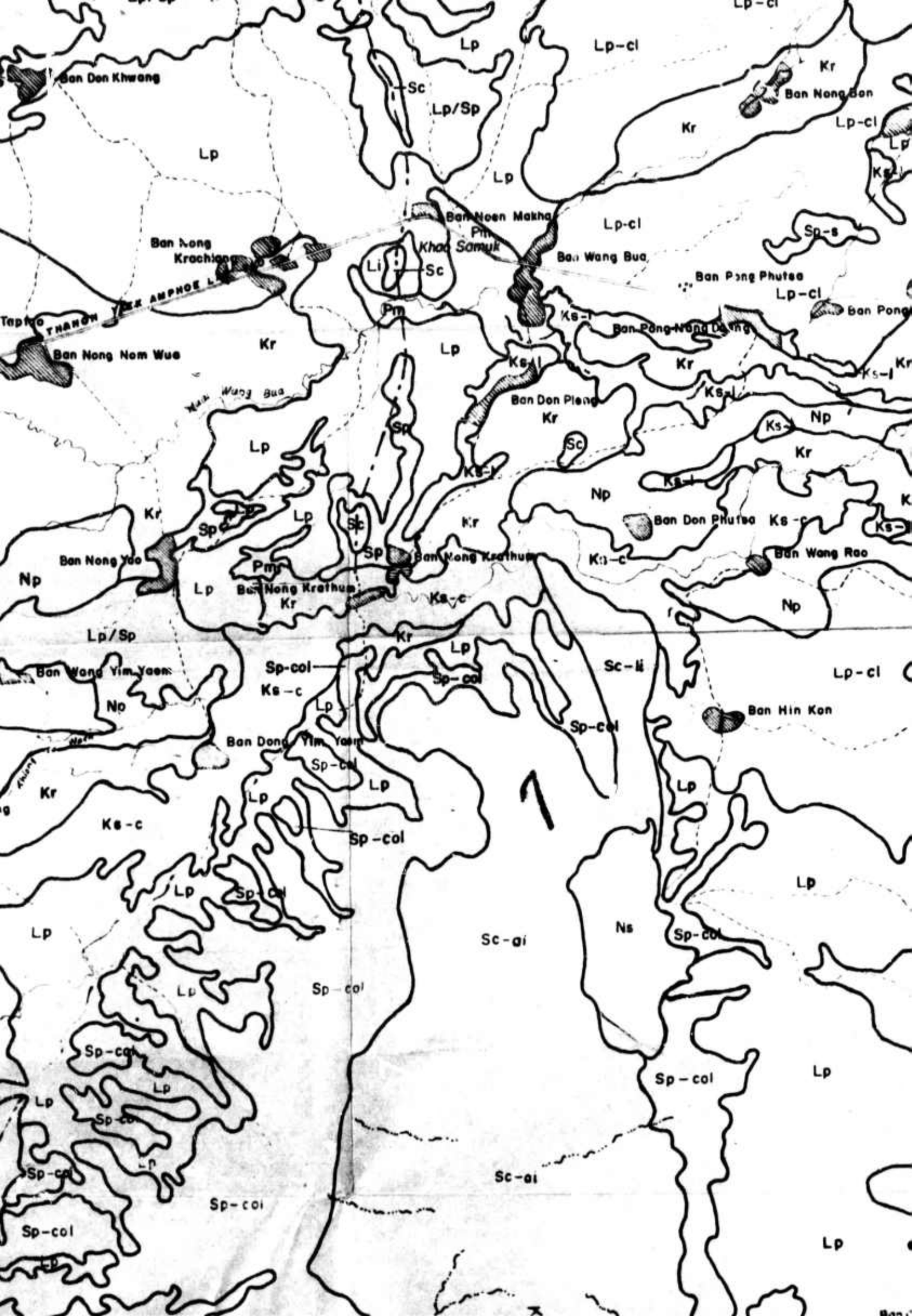
3

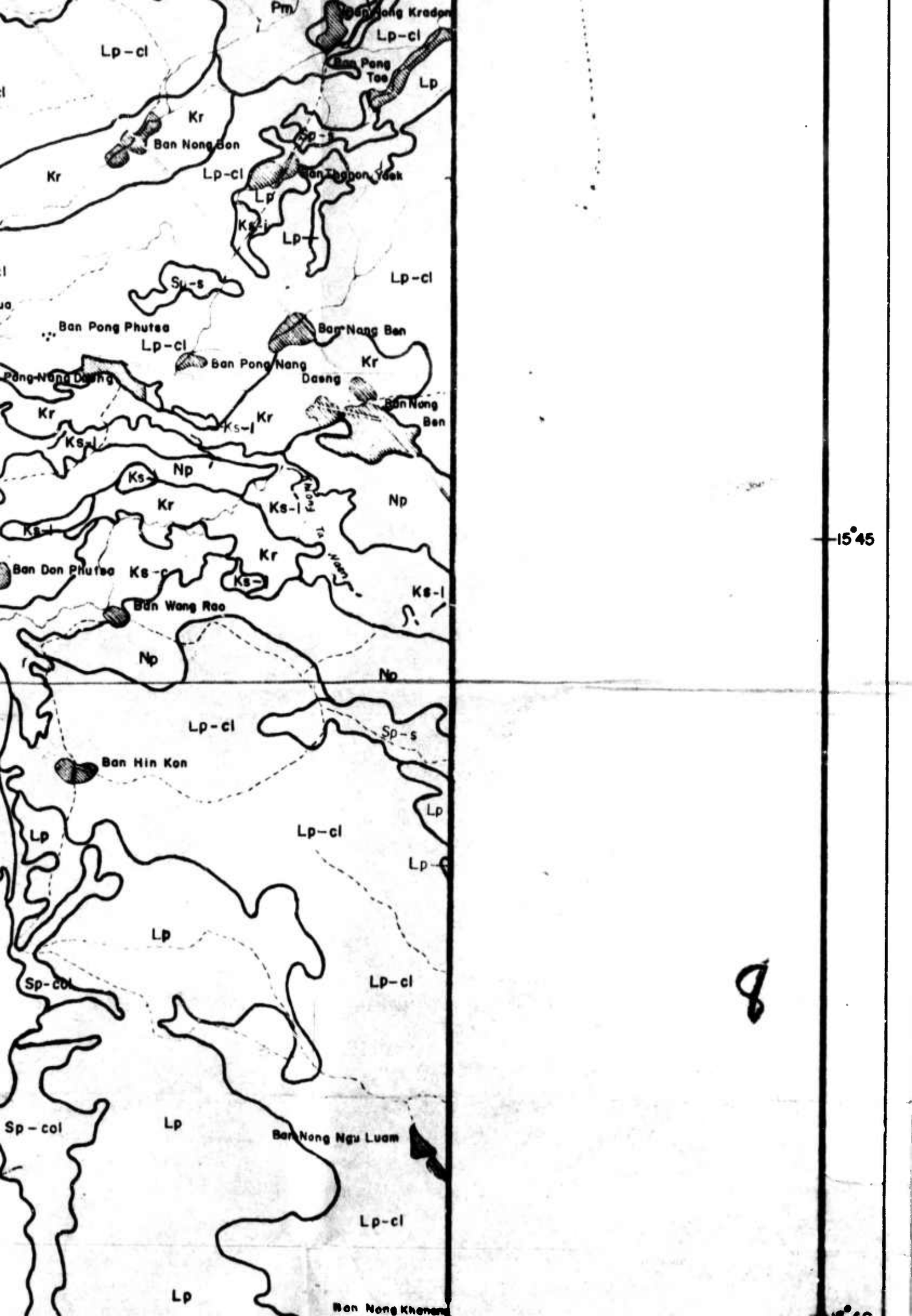

Lp-cl
Sp-s
Lp
Rb
Ban Bua Khao
Ban Don
Sb
Sp
Lp-cc
Ban Tha Rae
Ban Nong Khuchon
Ban Nong Saeng
Ban Nong Nam Khiao
Ban Khlong Chan
Ban Ang Thong
Ban Don Yai
Kr
Lp/Sp
Ban Don Ngam
Ban Nong Takhong
Tk
Sc

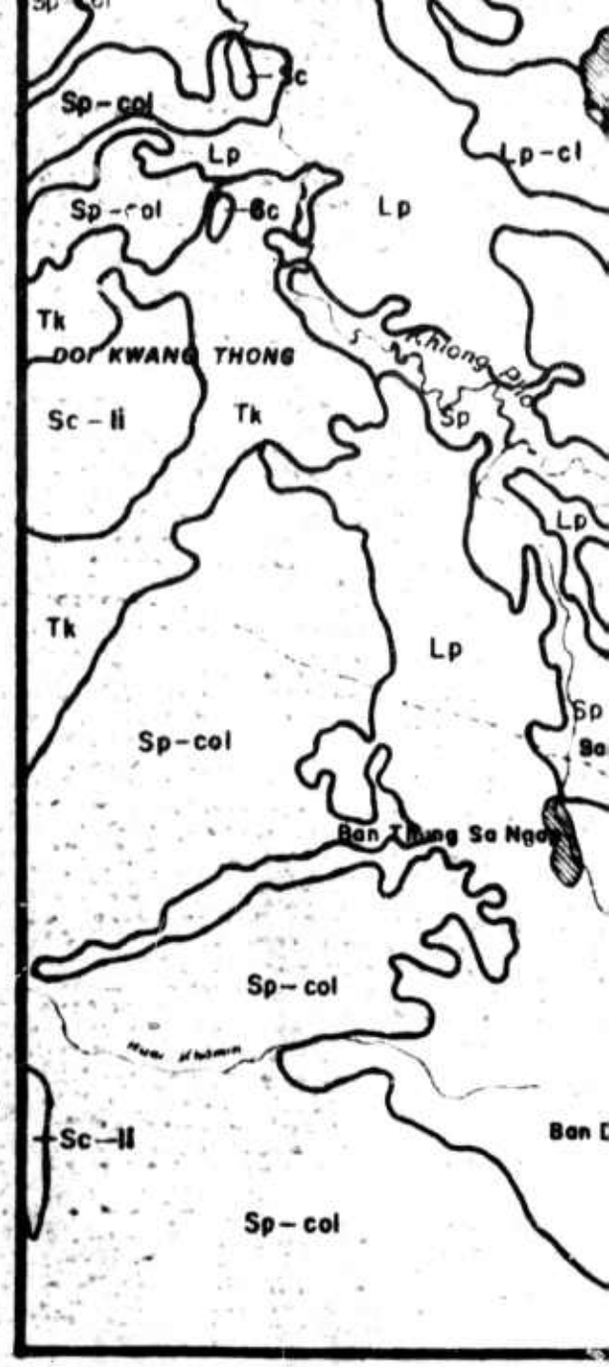

100°00
15°55
15°50
Cn
Pm
Ks
Rb
Sb
Sp-s
Lp-cl
Lp
Kr
Sp
Lp-c
Ban Wang Kakhon
Ban Don Yae
Ban Don Ngam
Ban Khok Sam
Pm


Sp-s
Kr
Pm
Sp-s
Kr
Ks-s
Ban Lom Tai
Ks-l
Kr
Lp
Np
Lp
Lp
Np
Lp
Ks-c
Np
Lp
Np
Ks-c
Sp-col
Sp-col
Sc
Lp
Sp-col


Ban Nong Mbao
Ban Suan Khwan
Kr
Sp
Lp-cl
Ban Nong Chik
Ban Noen Makham Pom
Ban Don Sisiat
Lp / Sp
Ks-l
Ban Nong Khamphong
Ban Noen Taphao
Ban Nong Kraduk Nua
Ban Pong Yo
Lp
LAT YAO
Ban Don Mo
Ban Huai Ruam
Np
Ban Nong Yao
Ban Salatdat
Ban Yang Thon
Ban Nong Pham
Ks-c
Ban Wang
Ban Nong Khaem
Ban Dan Phlang
Ban Wang Muang
Ban Khlong Tai Khao
Tm
Np-a
Sp-col
Lp-cl
6

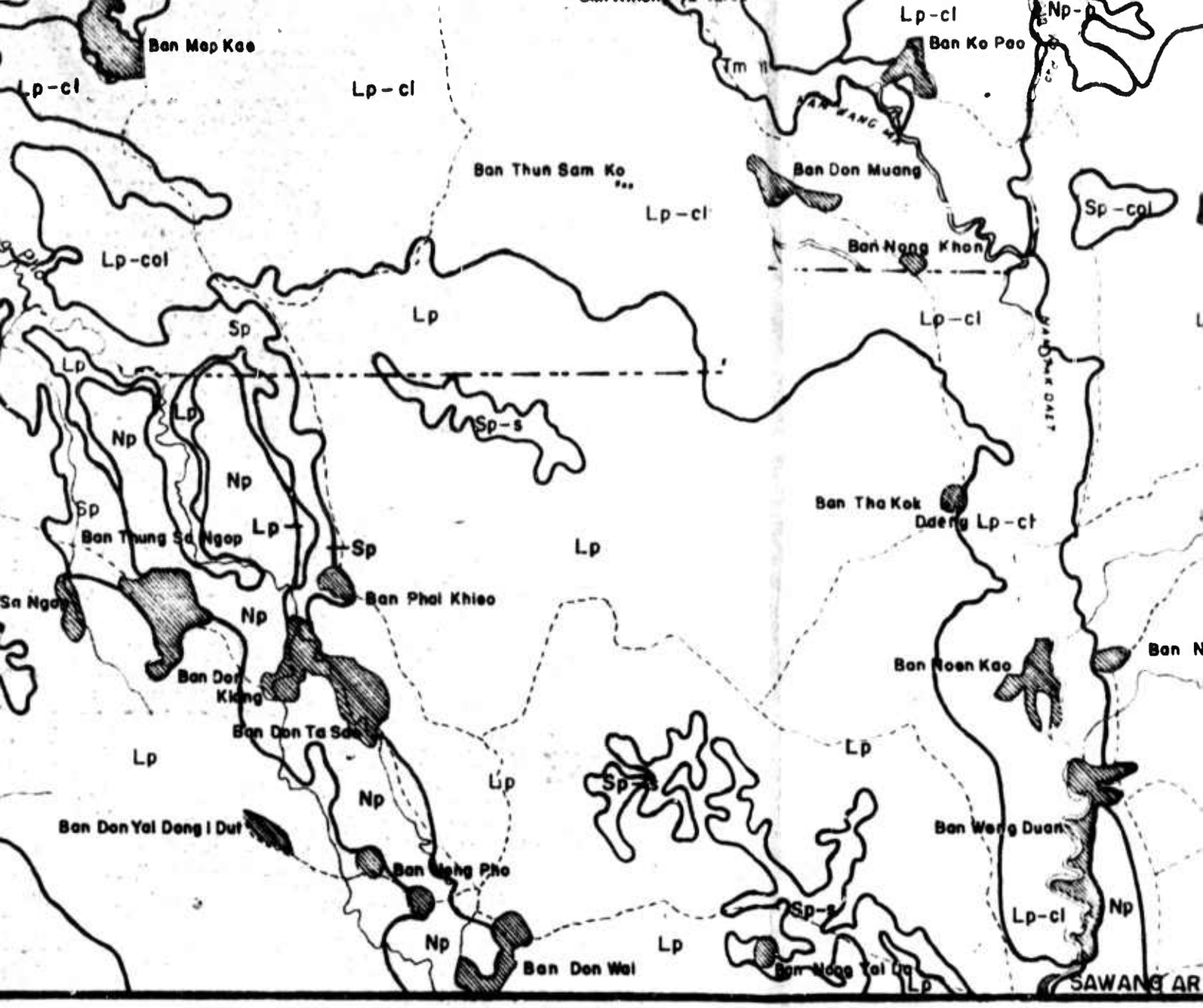

Ban Don Khwang
Lp
Sc
Lp/Sp
Lp-cl
Kr
Ban Nong Ban
Ban Noen Makha
Khao Samuk
Ban Nong Krachiang
Li
Pm
Ban Wang Bua
Sp-s
Ban Pong Phutsa
Ks-l
Ban Pong-Nong Daeng
Ban Pong
Tapkho
Ban Nong Nom Wue
Kr
Ban Don Plang
Np
Ks-c
Ban Don Phutsa
Ban Wang Rao
Ban Nong Yao
Ban Nong Krathum
Sp
Sc-li
Ban Wang Yim Yaem
Sp-col
Ban Hin Kon
Ban Dong Yim Yaem
Ns
Sc-ai


Pm
Lp-cl
Ban Pong Toe
Lp
Kr
Ban Nong Bon
Ban Thapon Yaek
Ks-l
Sp-s
Ban Pong Phutsa
Ban Nong Ben
Ban Pong Nang
Daeng
Np
Ban Don Phutsa
Ks-c
Ban Wang Rao
Sp-s
Ban Hin Kon
Lp
Sp-col
Ban Nong Ngu Luam
15°45



• CONVENTIONAL SYMBOLS •

- Urban area
- Road
- Road under construction
- Track and footpath
- River
- Stream and creek



LEGEND

Soil series and phases

Cn	Chainat series
Rb	Rat Buri series
Pm	Phimai series
Yp	Yang Pong series

Terrace alluvium & Slope colluviums

Sb	Sara Buri series

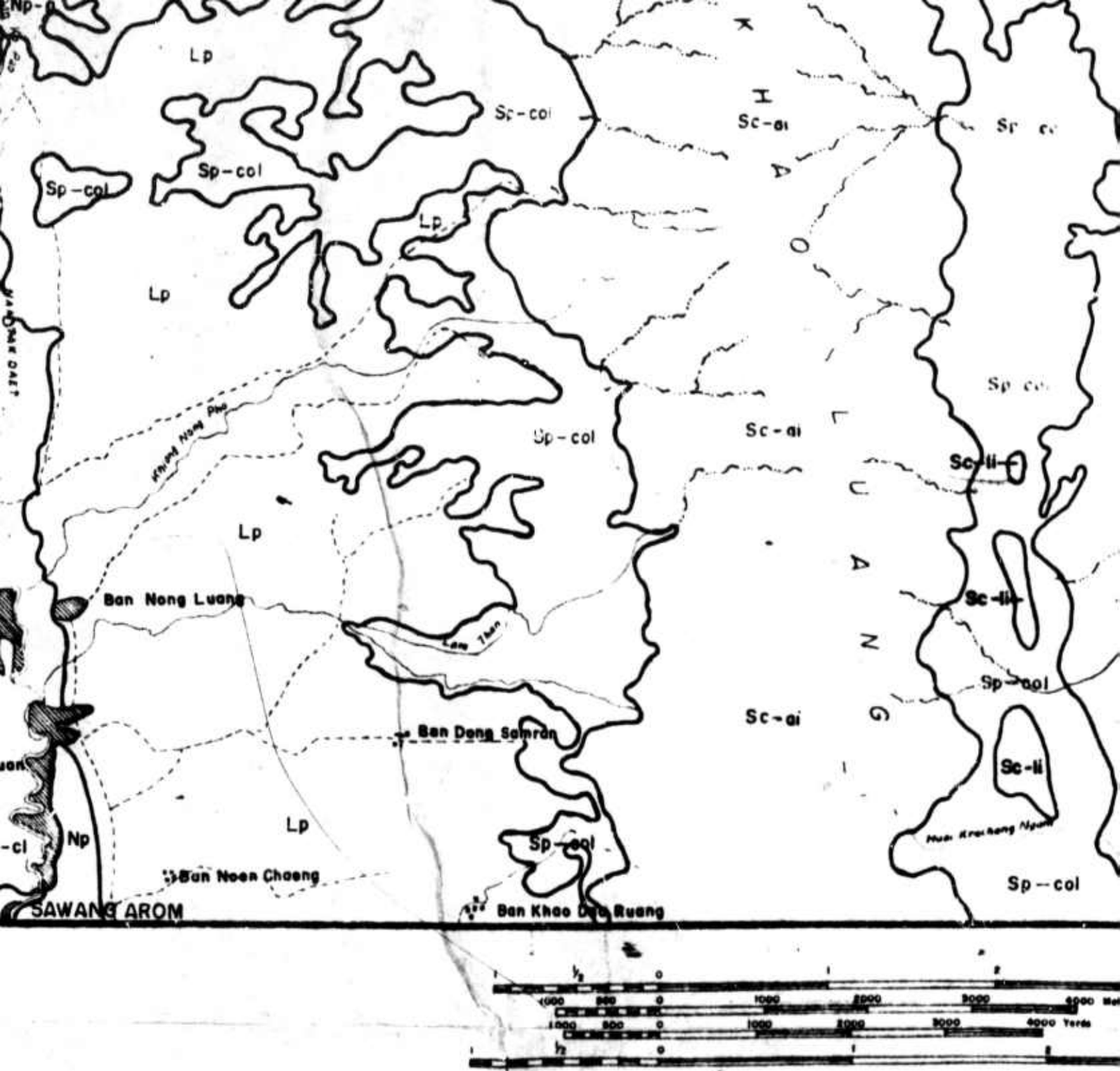
Sp	San Pa Tong series
Sp-s :	San Pa Tong series
Sp-col:	San Pa Tong series
Ly	Lat Ya series

Residuum & colluviated residu

Tk	Takli series
Li	Li series

OTHER UNITS

10



n Pa Tong series

n Pa Tong series sandy phase

n Pa Tong series colluvial phase

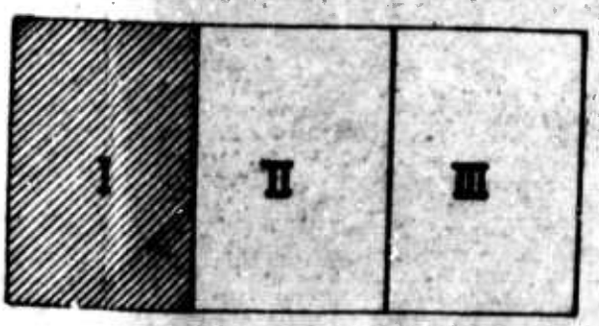
t Ya series

lluviated residuum

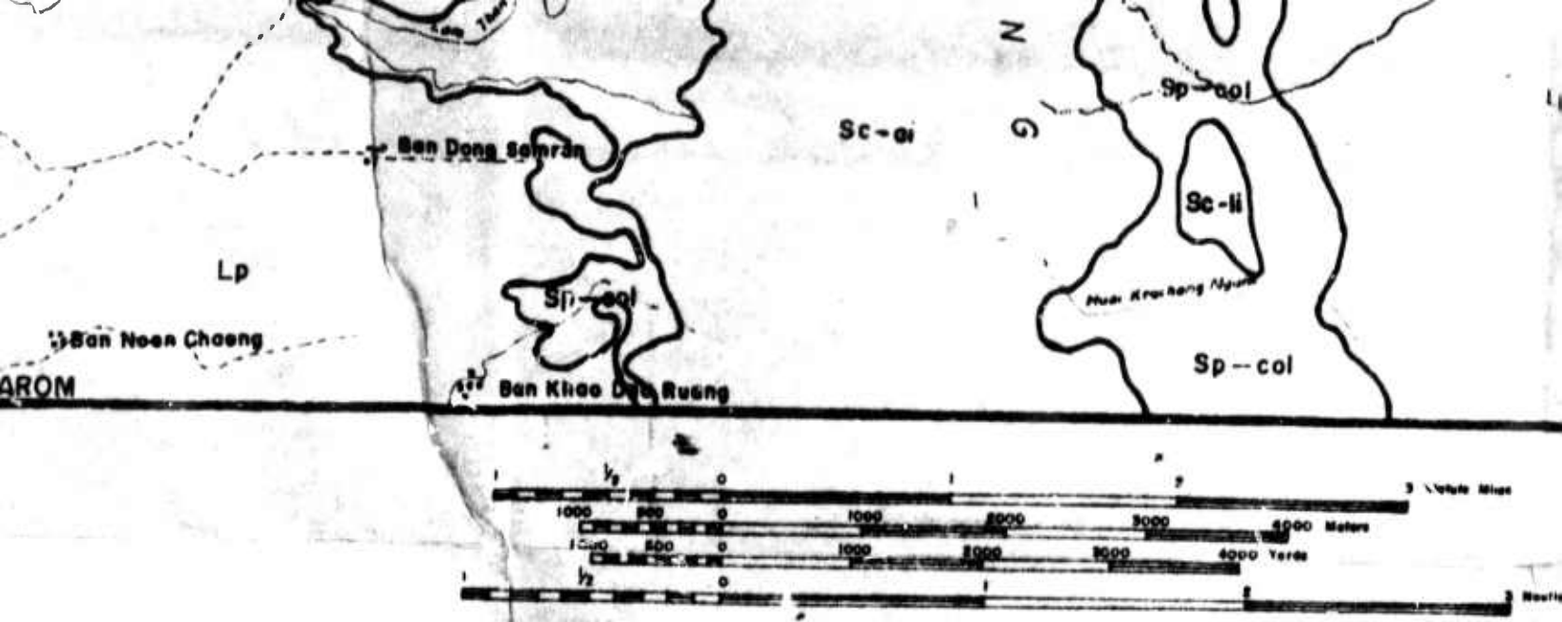
kli series

series

INDEX MAP



KINGDOM OF THAILAND



es

s sandy phase

s colluvial phase

duum

complex

Pa Tong series

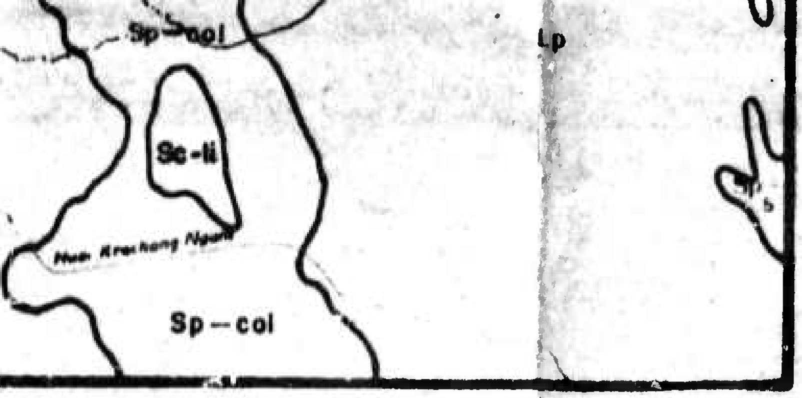
15

NAI

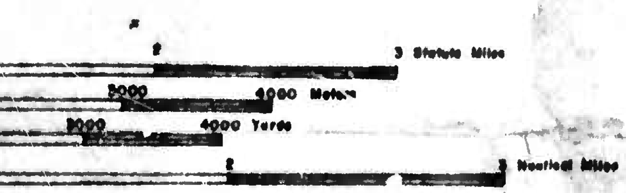
SU
DR
TR
CH

SOIL S

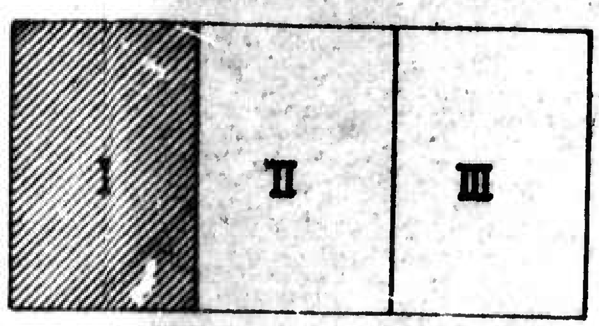
To



15°36



INDEX MAP



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KINGDOM OF THAILAND

MINISTRY OF NATIONAL DEVELOPMENT

DEPARTMENT OF LAND DEVELOPMENT

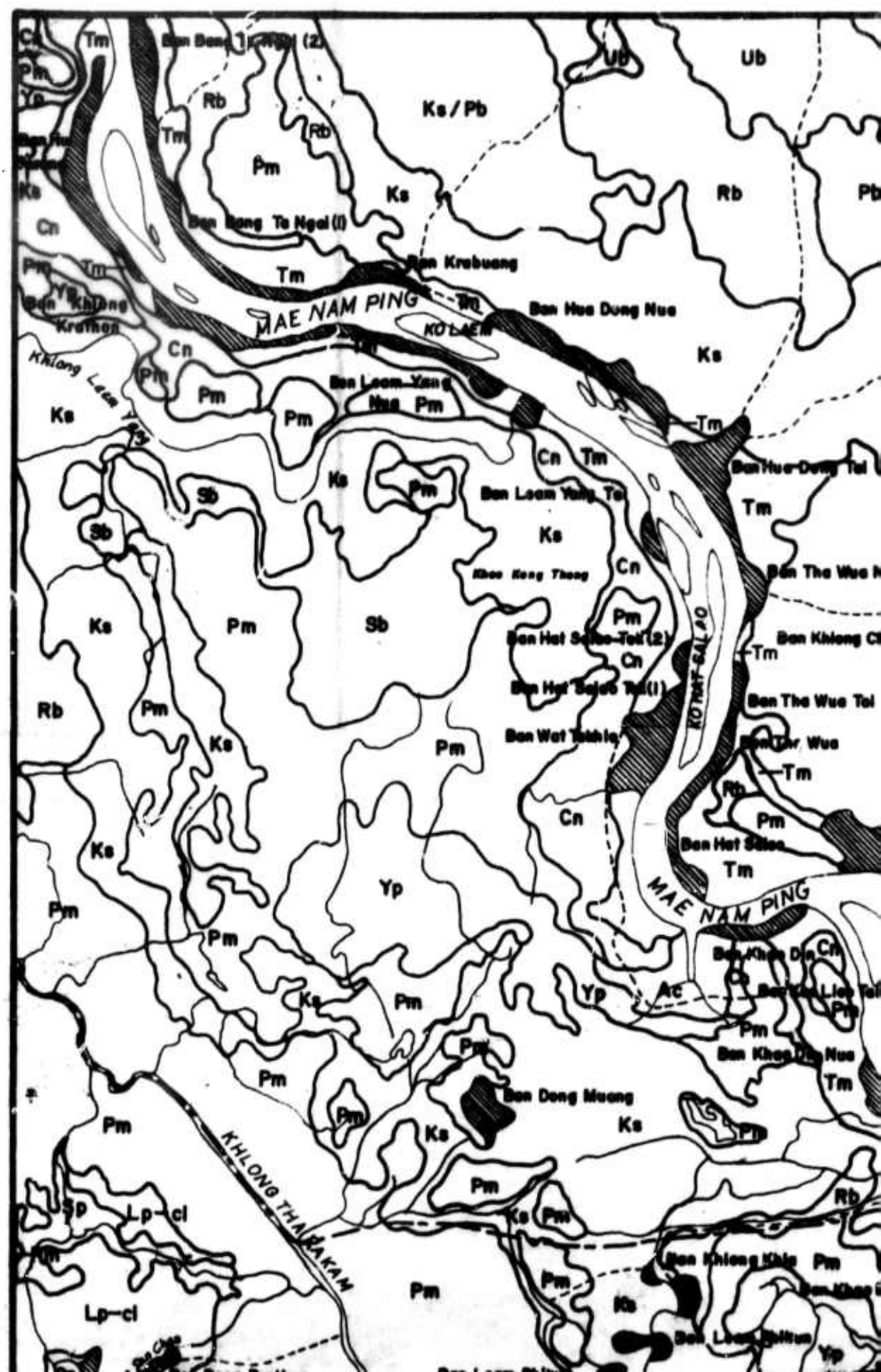
SOIL MAP OF THE MERS NAKHON SAWAN STUDY AREA, APP.A

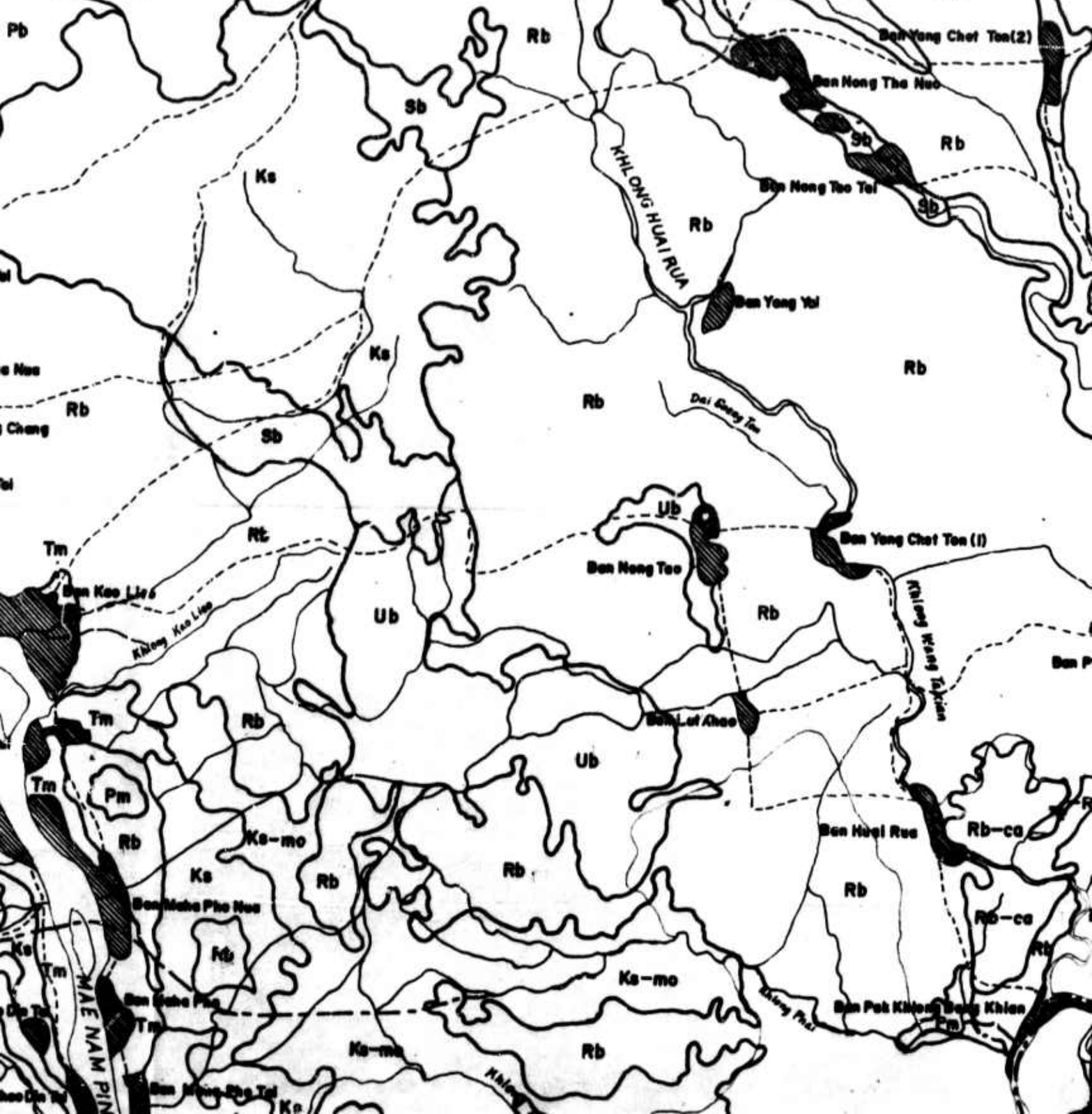
Sheet I of 3 sheets

SURVEY	Lek Moncharoen
DRAWN	Udom Uebrakna
TRACED	B. Sumprapham
CHECKED	F. Moormann

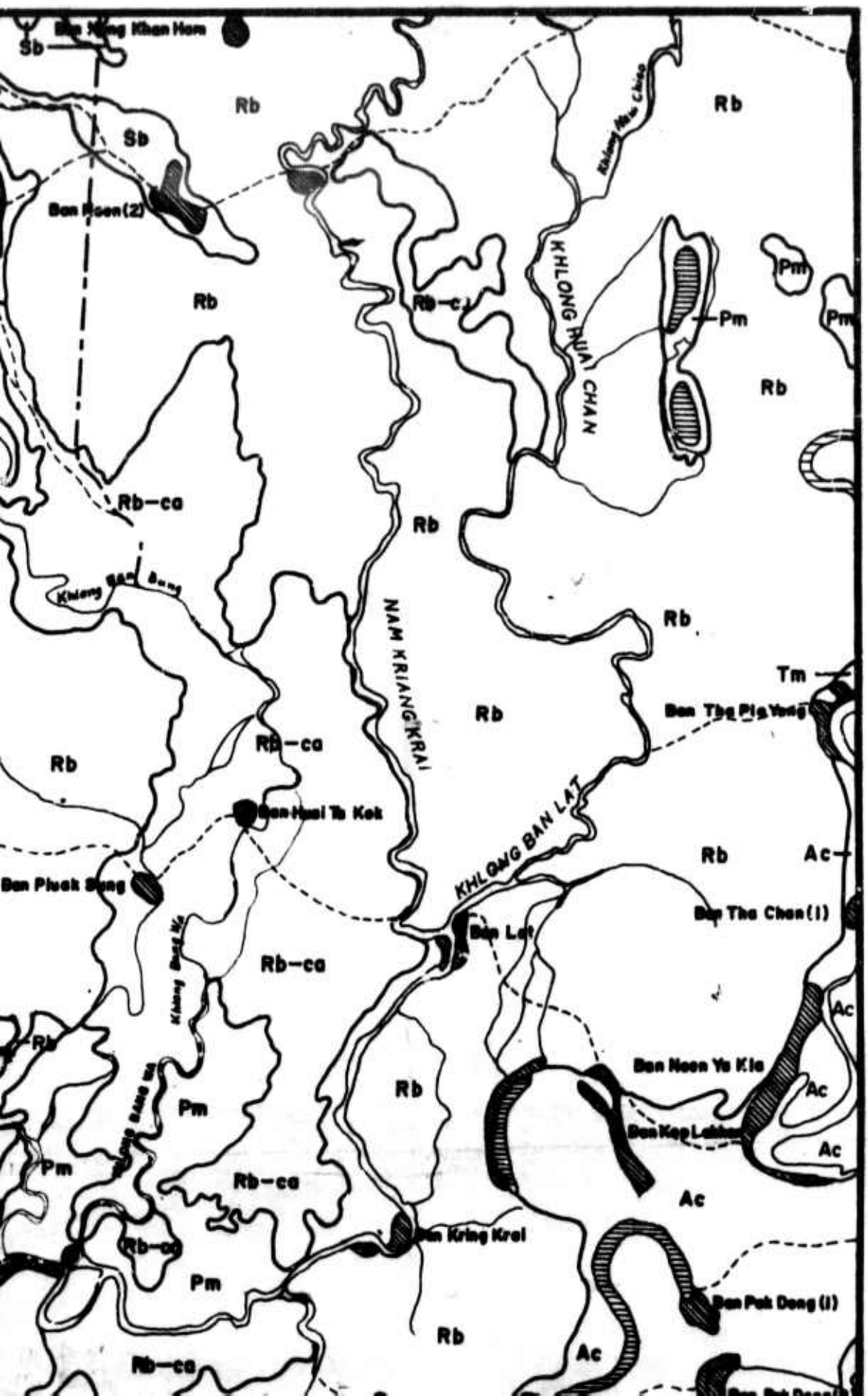
SOIL SUVEY DIVISION, BANGKOK 1965 | SSR-52-1

Topography after AMS series L 708


Tm
Ks / Pb
Ub
Rb
Pm
Ks
Cn
Ban Krabuang
MAE NAM PING
Ban Hua Dong Nua
KO LAEM
Ban Loam Yang Nua
Ban Loam Yang Tai
Sb
Khao Kong Thong
Ban Hat Sajao Tai (2)
Ban Hat Sajao Tai (1)
KOHAT SALAO
Ban Tha Wua Tai
Ban Wat Tabhlo
Ban Hat Sajao
Yp
Ac
Ban Dong Muang
KHLONG THARAKAM
Sp
Lp-cl


05'
10'
Rb
Pb
Sb
Ks
Tm
Rt
Ub
Pm
Ks-mo
Rb-cg
Ban Noen Pho
Ban Deng I Mui
Ban Yang Chet Ton(2)
Ban Nong Tha Nae
Ban Nong Tao Tai
KHLONG HUAI RUA
Ban Yang Yai
Dai Song Tan
Ban Yang Chet Ton (I)
Ban Nong Tao
Khlong Kao Lio
Khlong Wang Takian
Ban Huai Rua
Ban Mae Pho Nua
Ban Pak Khlong Bang Khian
MAE NAM PING

3



LEGEN

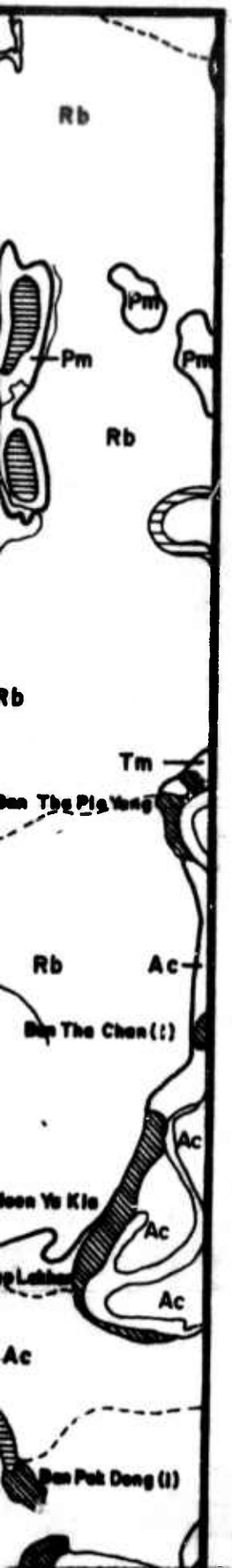
SOIL SERIES AND PHASE

Recent River Alluvium

Tm	Tha Mu[illegible] seri
Sa	Sapphaya series
Cn	Chainat series
Rb	Rat Buri series
	Rb–ca : Rat Bur
Pm	Phimai series
Yp	Yang Pong series
To	Tha Tako series

Terrace Alluvium and Slo

Sb	Sora Bu[illegible] series



LEGEND

SOIL SERIES AND PHASES

Recent River Alluvium

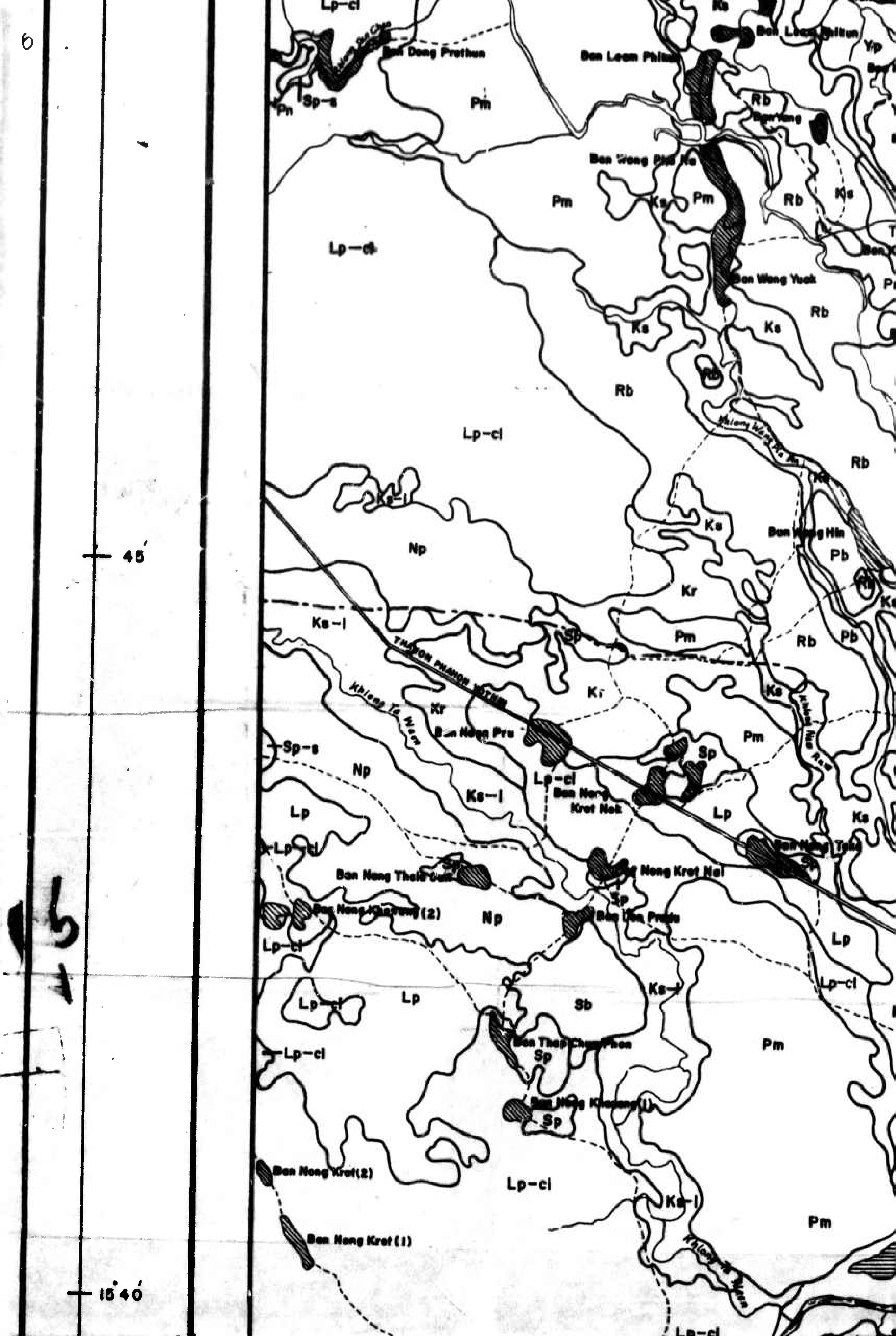
Tm	Tha Muang series
Sa	Sapphaya series
Cn	Chainat series
Rb	Rat Buri series
	Rb–ca : Rat Buri series, calcareous phase
Pm	Phimai series
Yp	Yang Pong series
Tc	Tha Tako series

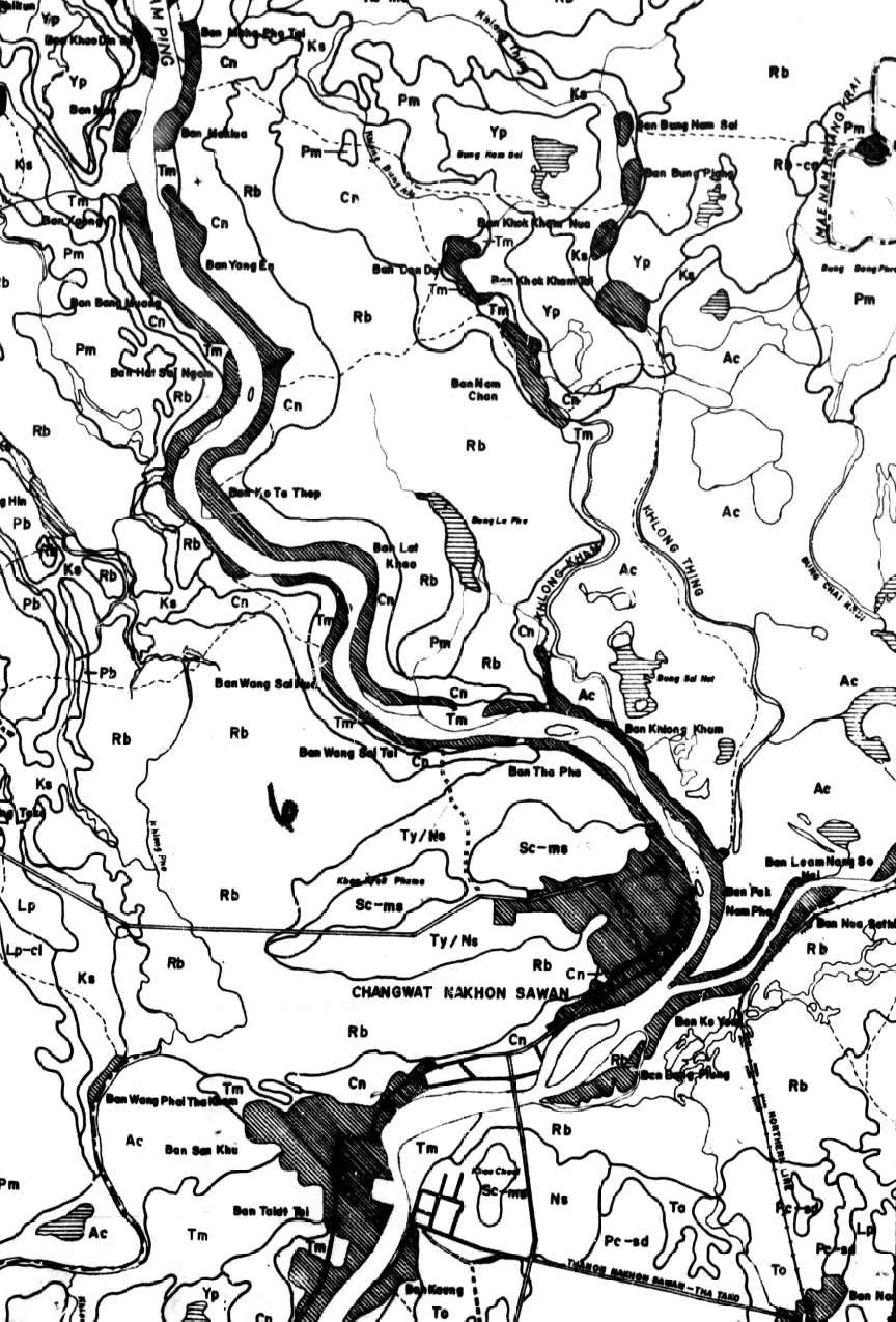
Terrace Alluvium and Slope Colluvium

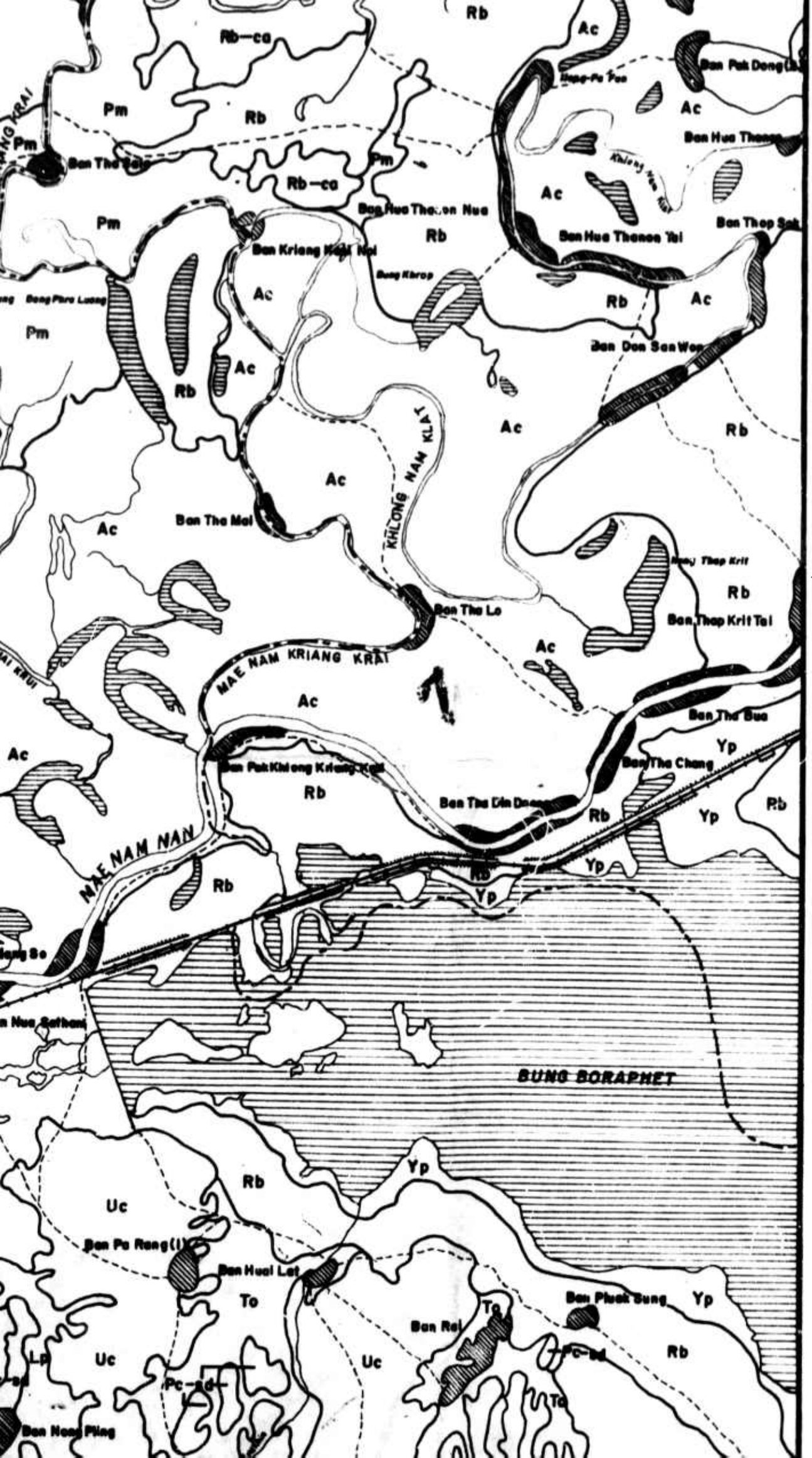
Sb	Sara Buri series

15°55′

15°50′


6
Lp-cl
Ban Dong Prathun
Sp-s
Pn
Pm
Ban Leam Phitun
Rb
Ks
Pm
Lp-cl
Ban Wang Yuak
Rb
Ks
Lp-cl
Rb
Ks-l
Np
Ban Wang Hin
Pb
Ks
Kr
45′
Ks-l
Sp
Pm
Rb
Pb
THANON PHAHON YOTHIN
Kr
Khlong Ta Wam
Kr
Ban Nong Pru
Ks
Pm
Sp-s
Np
Sp
Lp-cl
Ban Nong Krot Nok
Ks-l
Lp
Lp
Ks
Lp-cl
Ban Nong Krot Nai
Np
Lp
Lp-cl
Lp
Sb
Ks-l
Lp-cl
Pm
Sp
Sp
Ban Nong Krot (2)
Lp-cl
Ks-l
Pm
Ban Nong Krot (1)
15°40′
Lp-cl


CHANGWAT NAKHON SAWAN
Ban Bung Nam Sai
Bung Nam Sai
Ban Bung Phong
Ban Khok Kham Nua
Ban Khok Kham Tai
Ban Dan Dy
Ban Nam Chon
Ban Makluo
Ban Yang En
Ban Bang Muang
Ban Hat Sai Ngam
Ban Ko Ta Thap
Ban Lat Khao
Bung La Pho
Ban Wang Sai Nua
Ban Wang Sai Tai
Ban Tha Pho
Bung Sai Hat
Ban Khlong Kham
Ban Laem Nang So Nai
Ban Pak Nam Pho
Ban Nua Sathi
Ban Ko Yao
Ban Bung Plung
Ban Wang Phai Tha Kham
Ban San Khu
Ban Talat Tai
Ban Kaeng
Khao Chaeo
KHLONG THING
KHLONG KHAM
MAE NAM PHANG KRAI
Khlong Pho
NORTHERN LINE
THANON NAKHON SAWAN – THA TAKO
Rb
Cn
Tm
Pm
Yp
Ks
Ac
Pb
Lp
Lp-cl
Ty/Ns
Sc-ms
Ns
To
Pc-sd



Sb	S
Np	N
Pb	P
Ks	K K K
Kr	K
Ub	U
Lp	L L
Sp	S S S

Residuum an

Tk	T
Pc-sd	P
Ns	N
Ty	T

OTHER UNI

Soil Complex

Uc	Un
Ac	All
Sc	Sl Sc

Sb — Sara Buri series

Np — Nakhon Pathom series

Pb — Phet Buri series

Ks — Kamphaeng Saen series

Ks-l : Kamphaeng Saen series, leached phase

Ks-mo : Kamphaeng Saen series, mottled phase

Kr — Krok Phra series

Ub — Ubon series

Lp — Lampang series

Lp-cl : Lampang series, clayey subsoil phase

Sp — San Pa Tong series

Sp-s : San Pa Tong series, sandy phase

Sp-col : San Pa Tong series, colluvial phase

Residuum and Colluviated Residuum

Tk — Takli series

Pc-sd — Pak Chong shallow dark phase

Ns — Nakhon Sawan series

Ty — Tha Yang series

OTHER UNITS

Soil Complexes

Uc — Unnamed complex

Ac — Alluvial complex

Sc — Slope complex

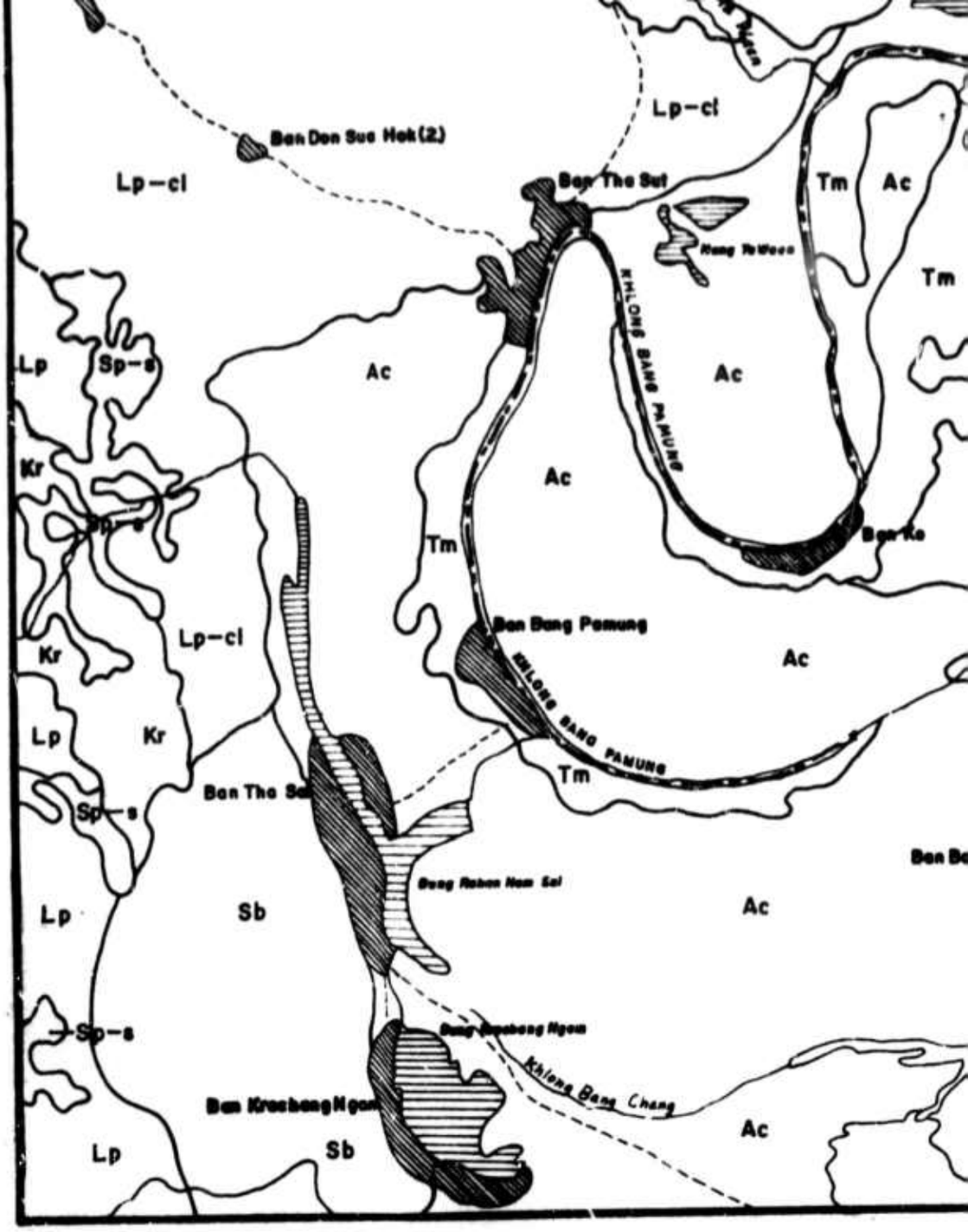
Sc-li : Limestone

45′

15°40′

15 40'

35'



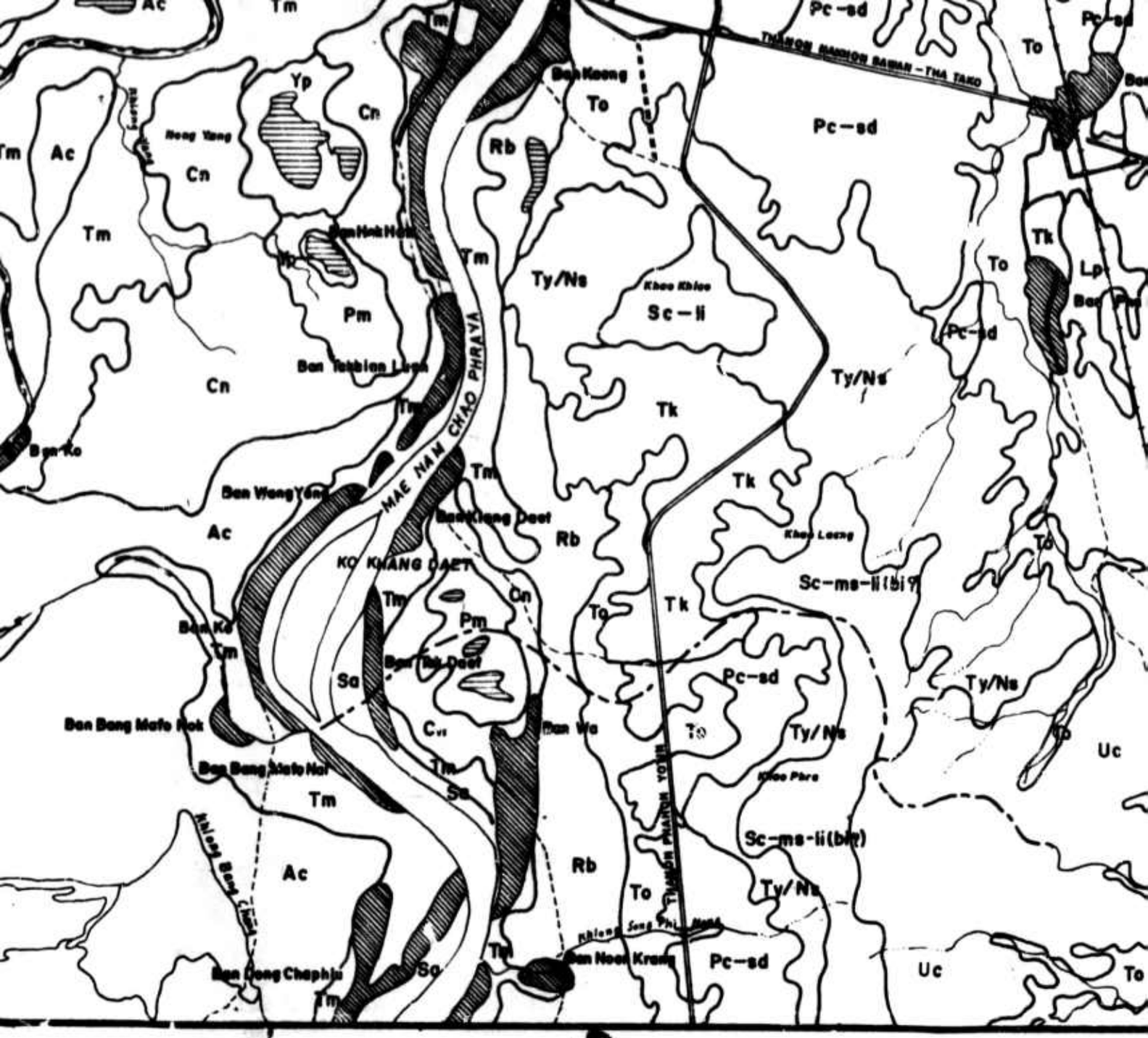
CONVENTIONAL S

Urban

Roads

Road under construction

Track and footpath



10

ONAL SYMBOLS

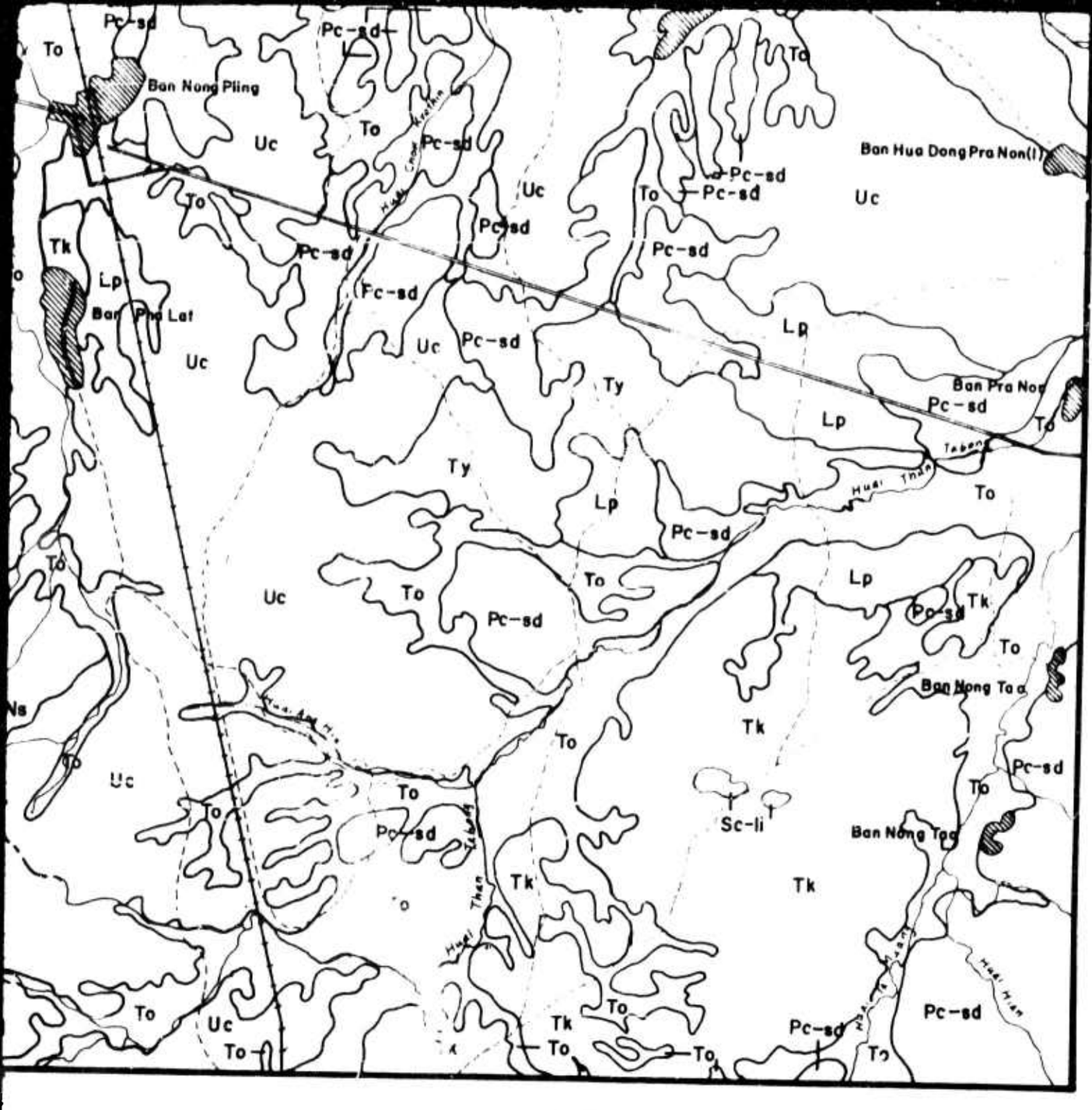
Lake

Stream and creek

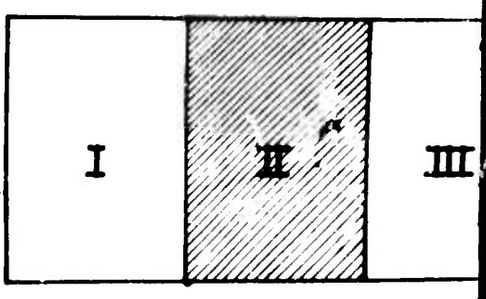
Amphoe boundary

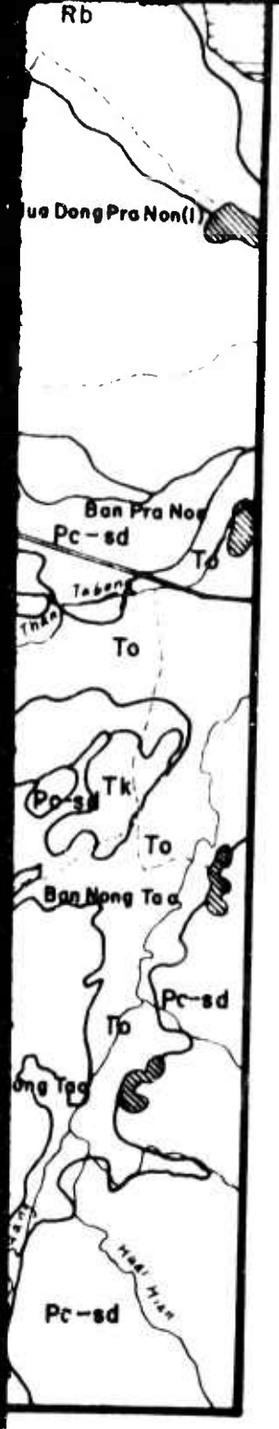
Soil boundary

N


Pc-sd
To
Ban Nong Pling
Uc
Tk
Lp
Ban Pha Lat
Fc-sd
Ty
Ban Hua Dong Pra Non(I)
Ban Pra Non
Huai Than
Ks
Ns
Sc-li
Ban Nong Taa
Ban Nong Taa
Pc-sd

INDEX MAP


I
II
III



Sc — Slope complex

Sc-li Limestone

Sc-ms-li (bi?) Mica schist some limestone and basic rocks inclusions

Sc-ms : Mica schist

Associations

Ty/Ns — Tha Yang and Nakhon Sawan series

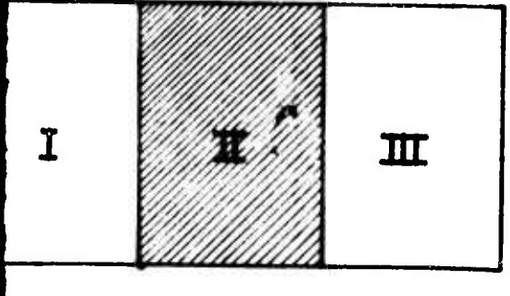
Ks/Pb — Kamphaeng Saen and Phet Buri series

15°40′

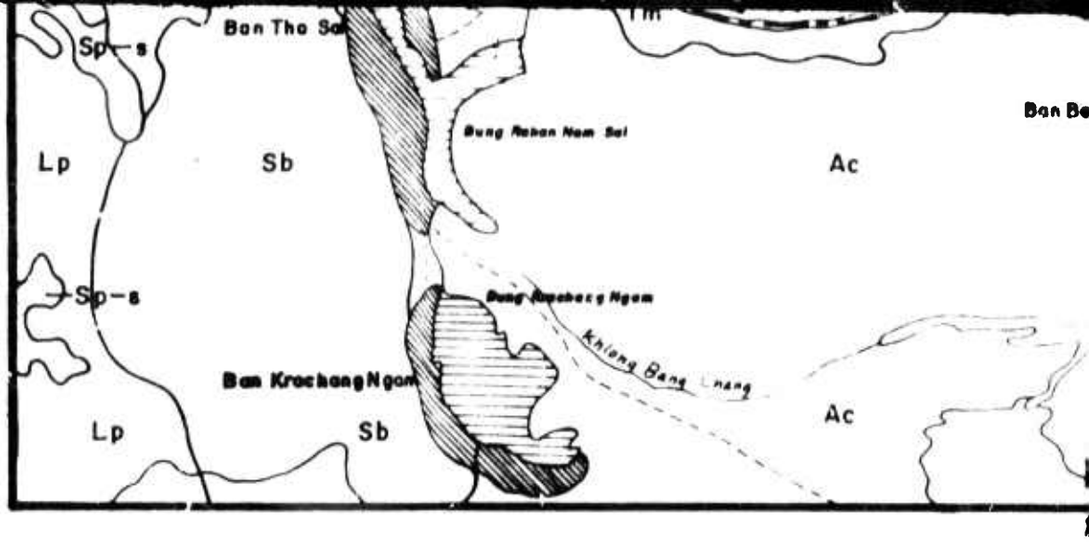
12

35′

INDEX MAP



KINGDOM OF THAILAND



35'

CONVENTIONAL SY

Urban

Roads

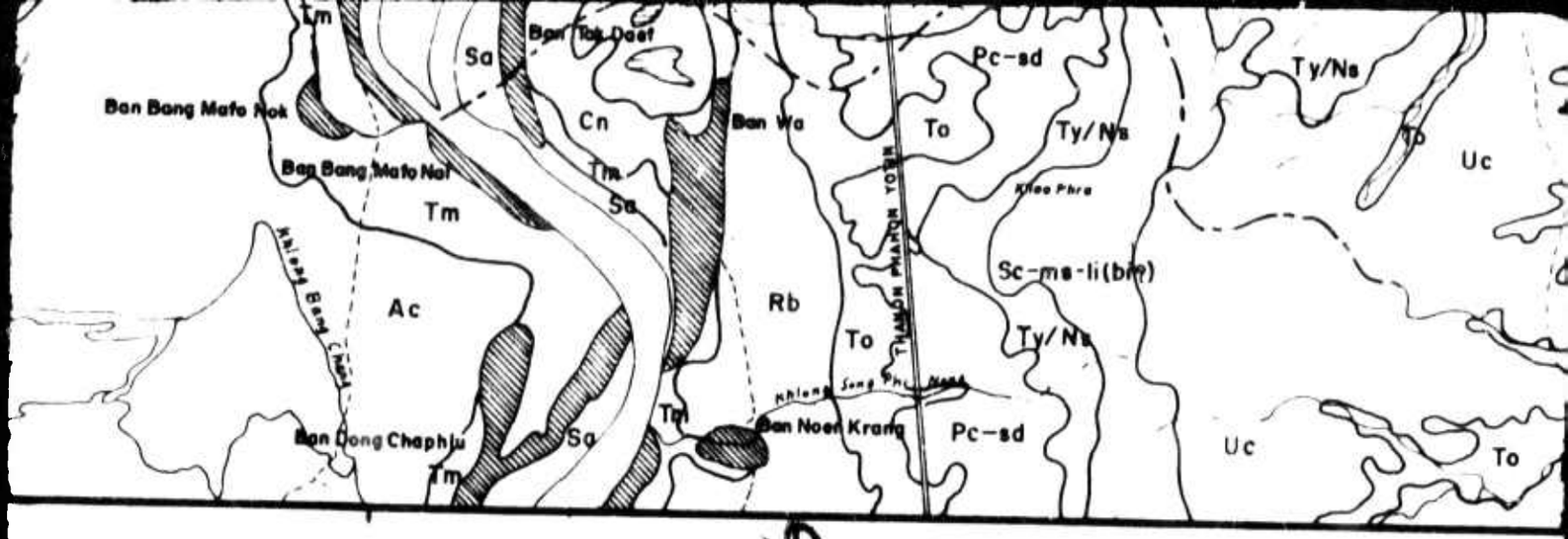
Road under construction

Track and footpath

Railroad (elevated)

Urban road and military street

River



10

ONAL SYMBOLS

Lake

Stream and creek

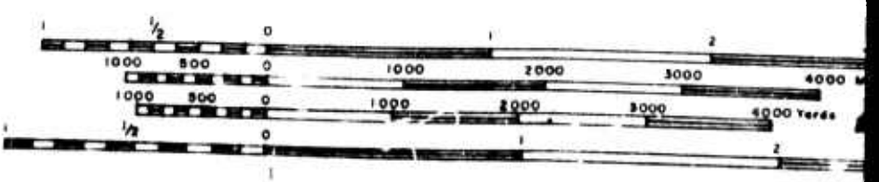
Amphoe boundary

Soil boundary

N.

Scale 1 50,000

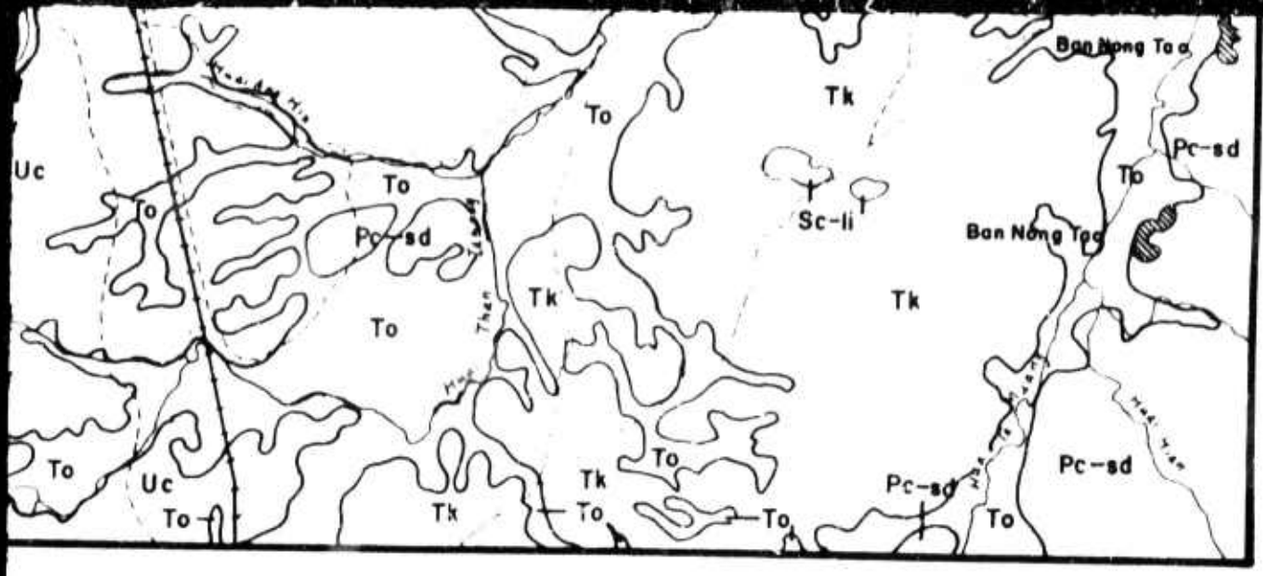
street



05′

10′

14



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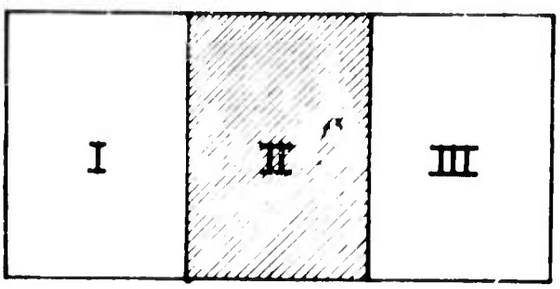
INDEX MAP



3 Statute Miles
4000 Meters
4000 Yards
2 3 Nautical Miles

MIN
DEPA
SO
NAKH

SURVEY
DRAWN
TRACED
CHECKED

SOIL SURVEY

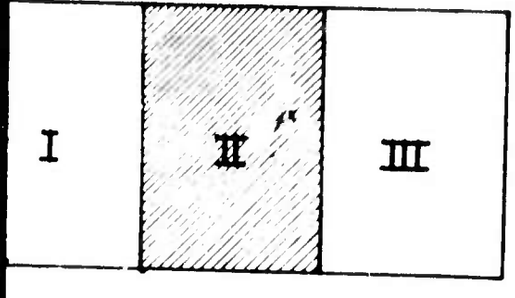
10

15

12

35

INDEX MAP



KINGDOM OF THAILAND

MINISTRY OF NATIONAL DEVELOPMENT

DEPARTMENT OF LAND DEVELOPMENT

SOIL MAP OF THE MERS NAKHON SAWAN STUDY AREA, APPA

Sheet II of 3 sheets

SURVEY Lek Ronchavan

DRAWN Udon Kabyakra

TRACED Somchai Tonkaew

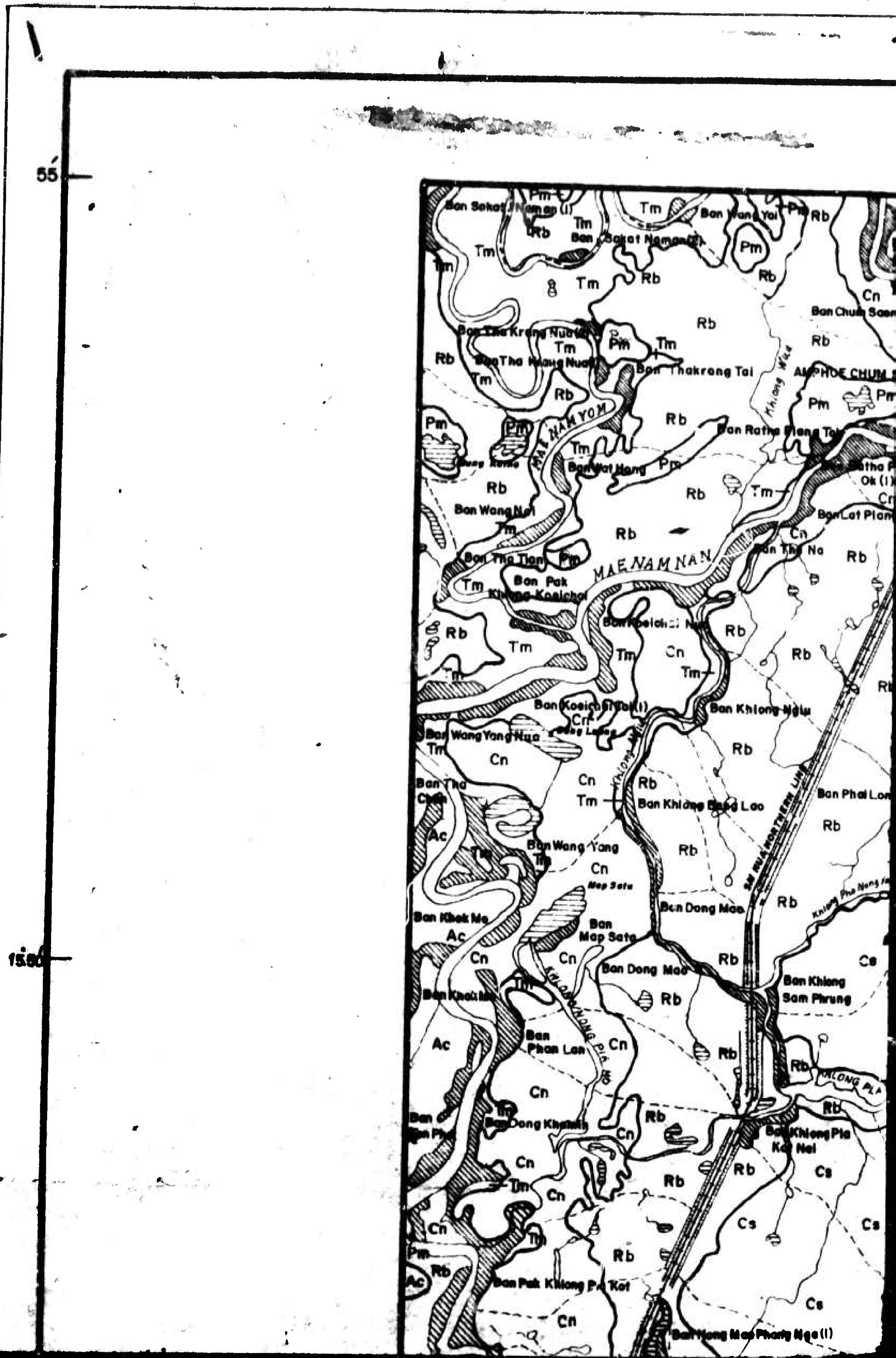
CHECKED

SOIL SURVEY DIVISION, BANGKOK 1965

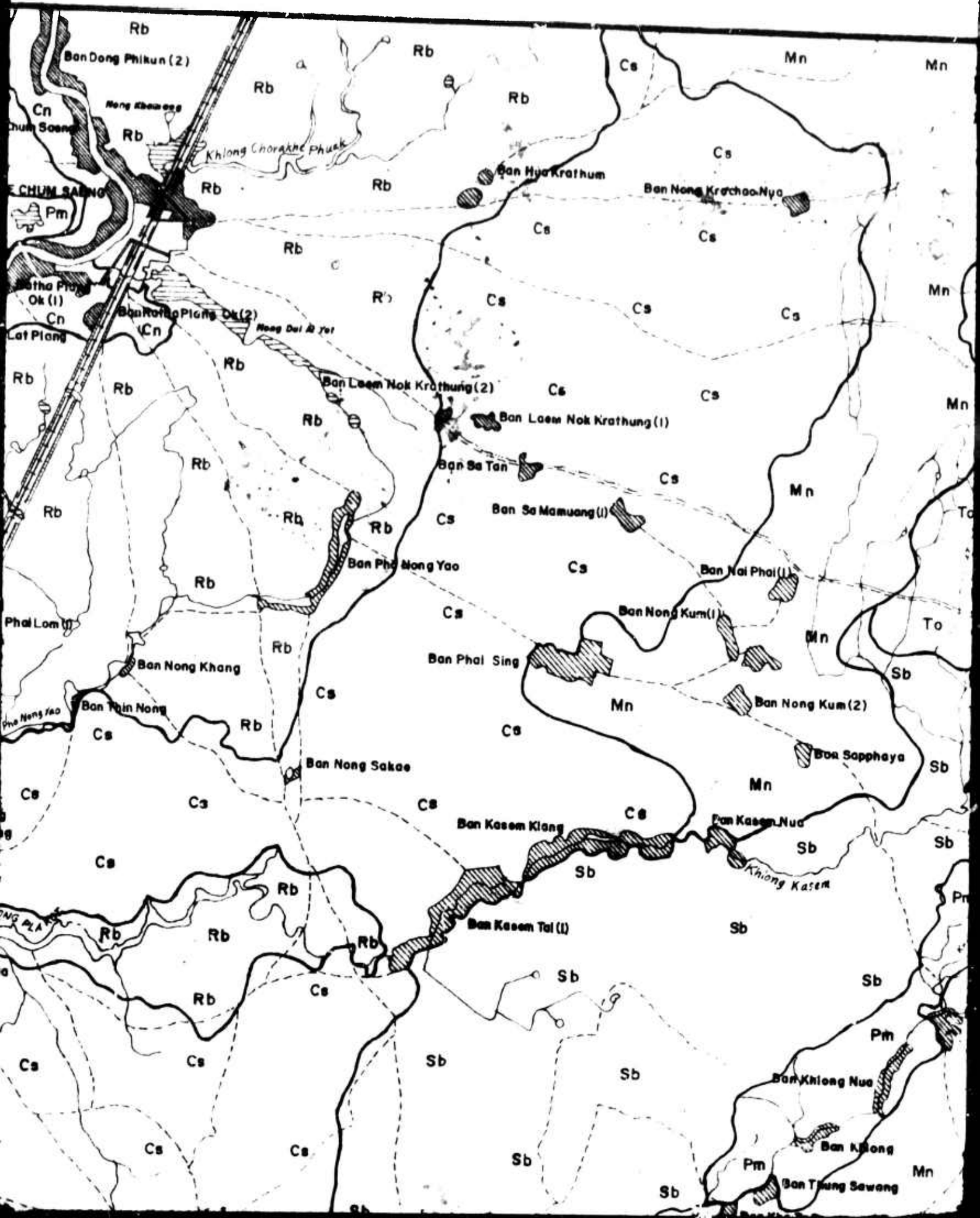
SSR 52-2

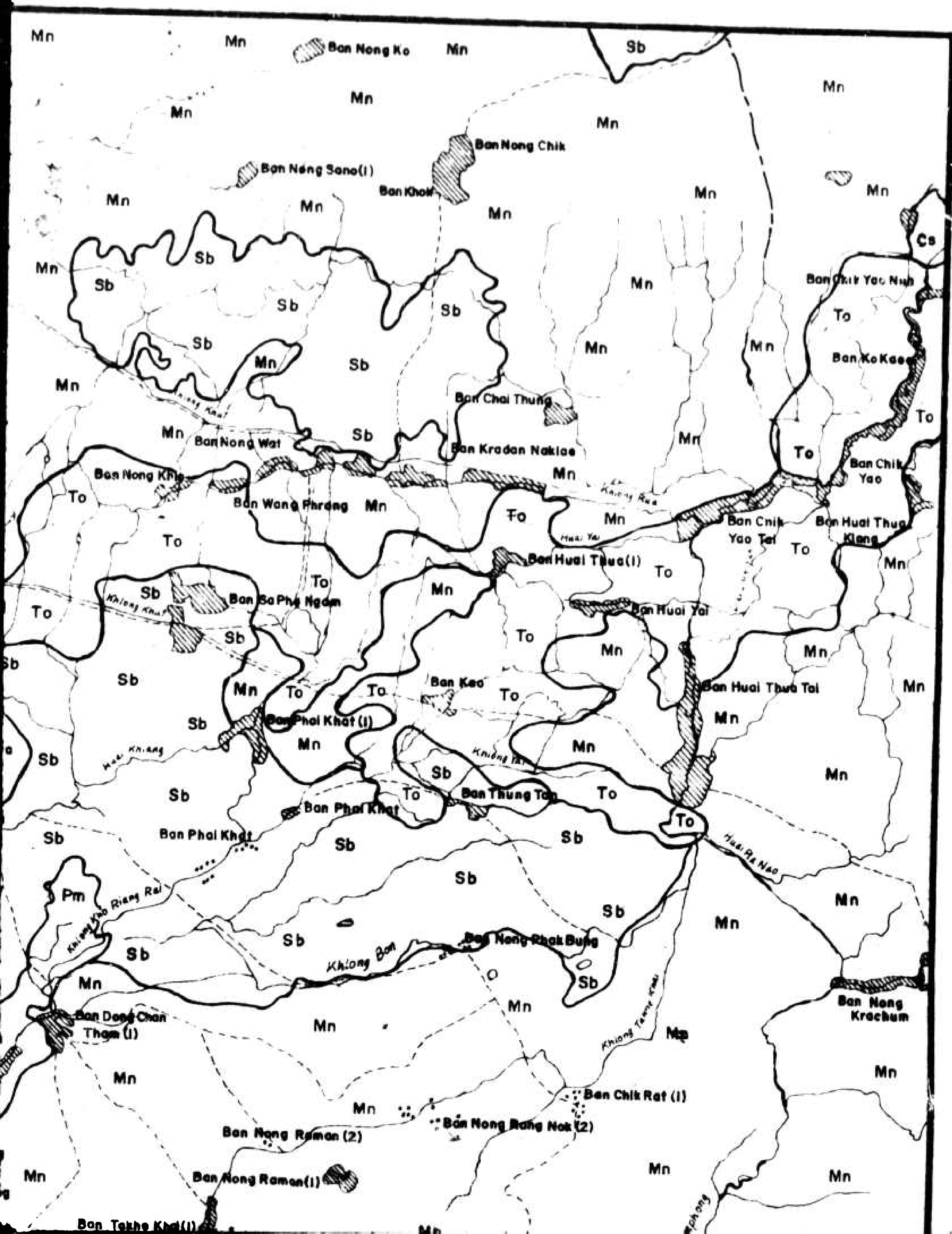
Topography after A M S series L 708

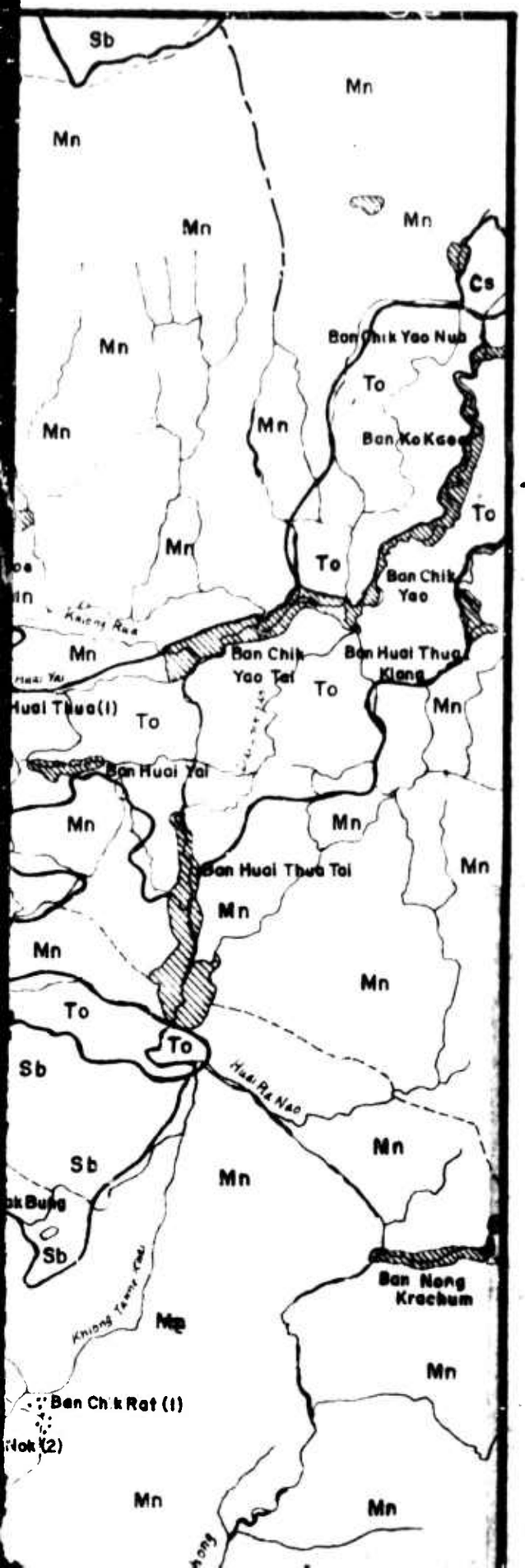
16


55'
15°50'
Ban Sakat Naman (1)
Ban Sakat Naman (2)
Ban Tha Krang Nua
Ban Tha Krang Nua
Ban Thakrang Tai
Ban Chum Saeng
AMPHOE CHUM SAENG
MAE NAM YOM
Ban Wat Hong
Ban Ratha Pleng Tai
Ban Wong Nai
Ban Lat Plang
Ban Tha No
MAE NAM NAN
Ban Tha Tian
Ban Pak Khlong Kosichai
Ban Kosichai Nua
Ban Kosichai Tai (1)
Ban Khlong Nalu
Ban Wang Yang Nua
Ban Tha Chan
Ban Khlong Bang Lao
Ban Phai Lom
Ban Wang Yang
Mop Sata
Ban Map Sata
Ban Khok Me
Ban Dong Mao
Ban Dong Mao
Ban Khlong Sam Phrung
KHLONG PLA
Ban Phan Lan
Ban Dong Khanun
Ban Khlong Pla Kot Nai
Ban Pak Khlong Pa Kot
Ban Nong Map Phang Nga (1)
SAI NUA NORTHERN LINE
Khlong Wua
Khlong Pha Nong
Rb
Tm
Pm
Cn
Ac
Cs

2


Ban Dong Phikun (2)
Khlong Chorakhe Phuak
Ban Hua Krathum
Ban Nong Krachao Nya
Ban Laem Nok Krathung (2)
Ban Laem Nok Krathung (1)
Ban Sa Tan
Ban Sa Mamuang (1)
Ban Phe Nong Yao
Ban Nai Phai (1)
Ban Nong Kum (1)
Ban Phai Sing
Ban Nong Kum (2)
Ban Sapphaya
Ban Nong Khang
Ban Thin Nong
Ban Nong Sakae
Ban Kasem Klang
Ban Kasem Nua
Khlong Kasem
Ban Kasem Tai (1)
Ban Khlong Nua
Ban Thung Sawang
Phai Lom (1)
Rb
Cs
Mn
Sb
Pm
Cn
To


Mn
Sb
To
Cs
Pm
Ban Nong Ko
Ban Nong Chik
Ban Nong Sano(1)
Ban Ko Kaeo
Ban Chai Thung
Ban Nong Wat
Ban Kradan Naklae
Ban Wang Phrang
Huai Yai
Ban Chik Yao
Ban Huai Thua(1)
Ban Huai Yai
Ban Keo
Ban Huai Thua Tai
Ban Phai Khat (1)
Ban Phai Khat
Huai Ra Nao
Khlong Bon
Ban Nong Phak Bung
Ban Nong Krachum
Ban Chik Rat (1)
Ban Nong Raman (2)
Ban Nong Raman(1)



LEGEND

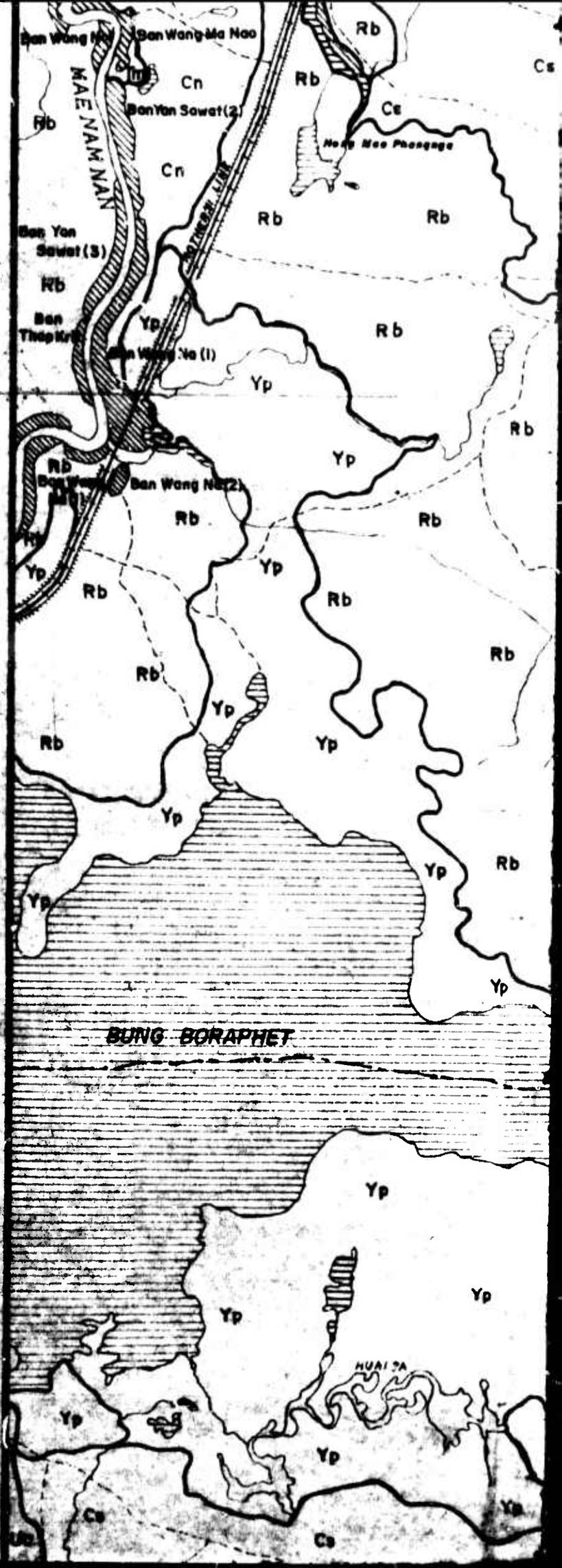
SOIL SERIES AND PHASES

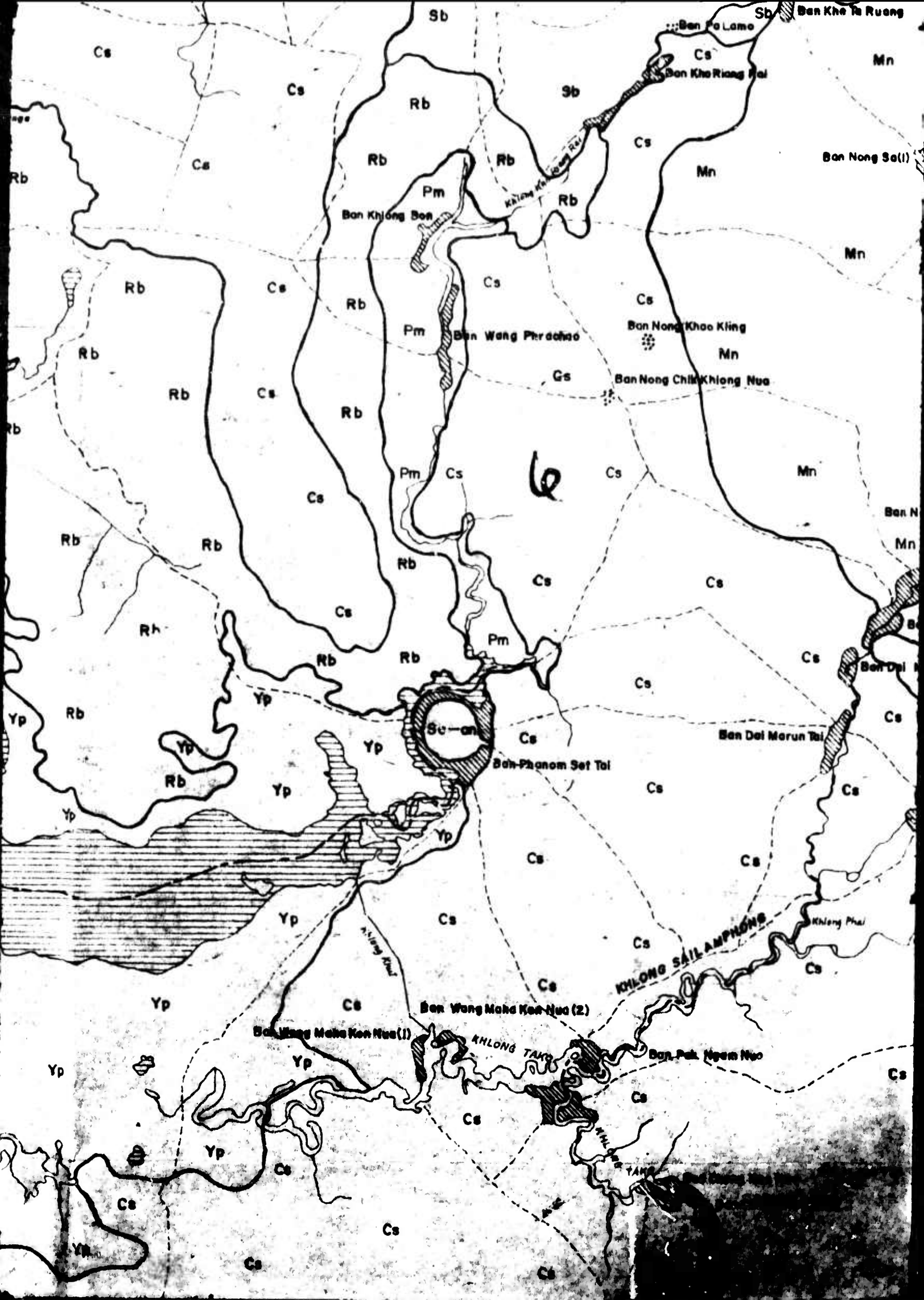
Recent River Alluvium

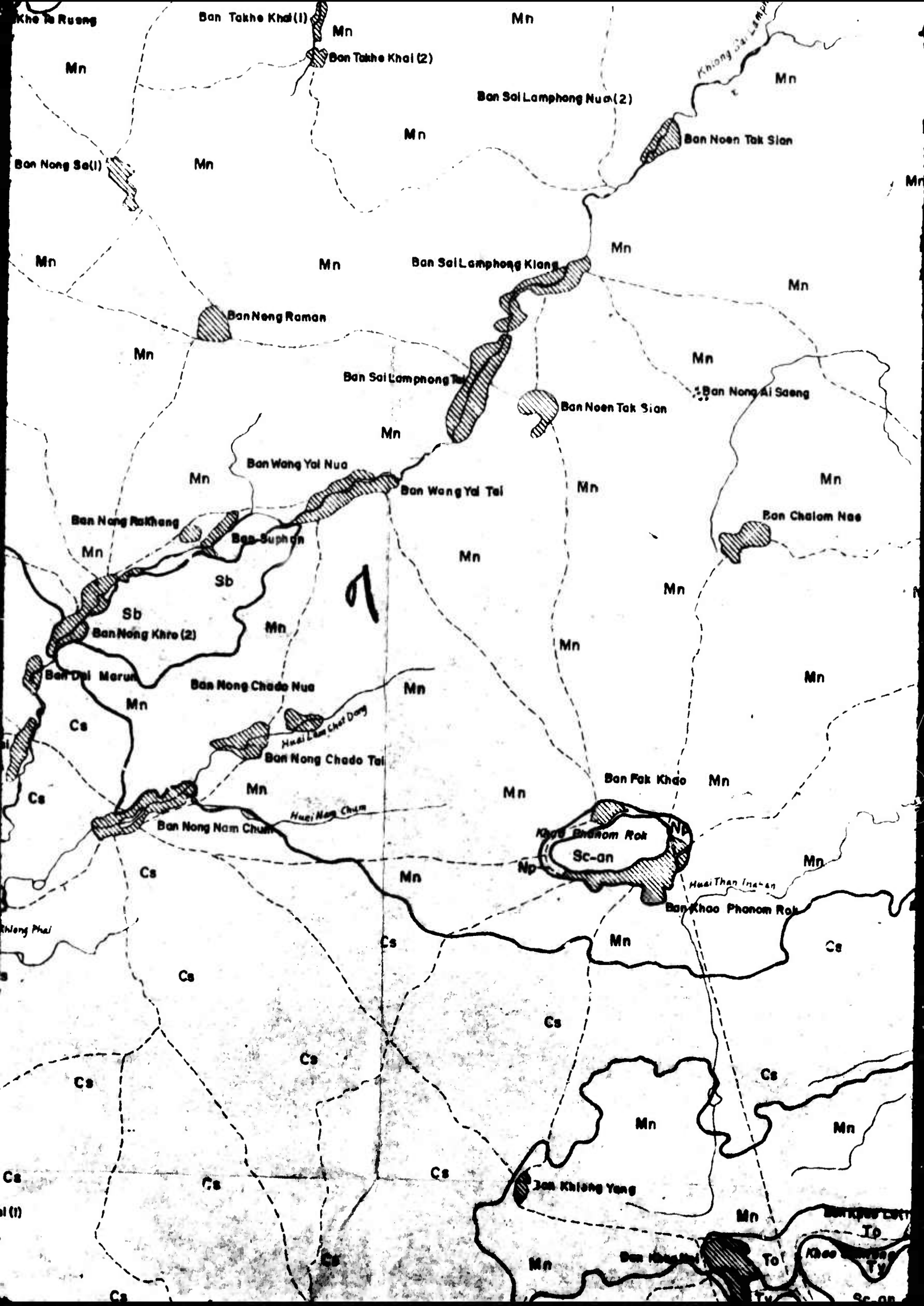
Tm	Tha Muang series
Cn	Chainat series
Rb	Rat Buri series
Pm	Phimai series
Yp	Yang Pong series
Cs	Chum Saeng series
To	Tha Tako series

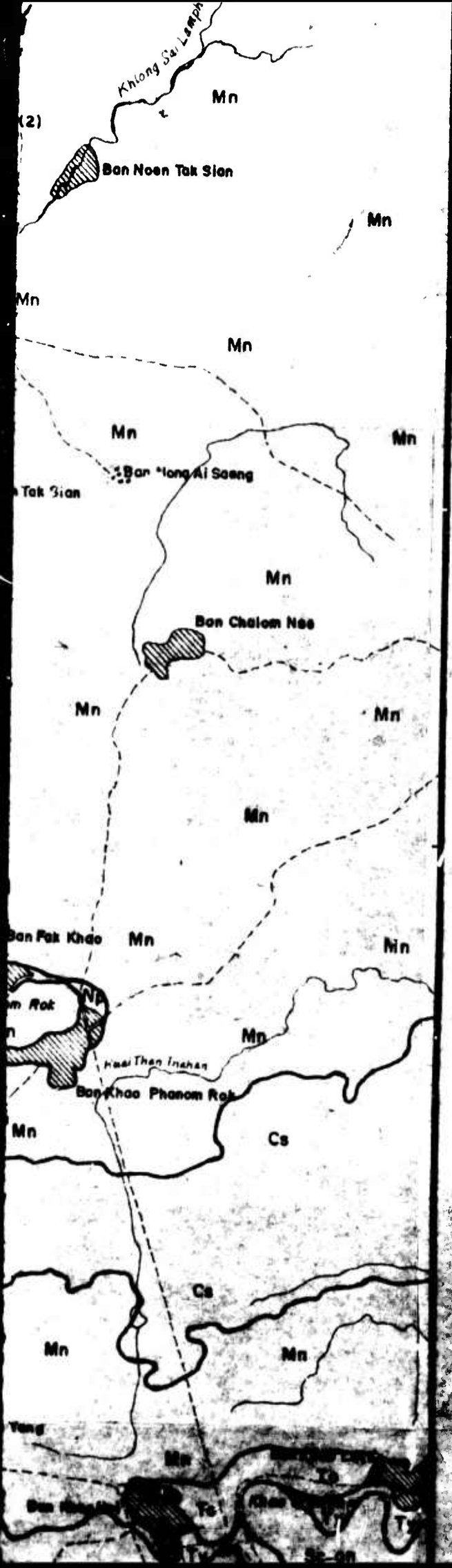
Terrace Alluvium and Slope Colluvium

Sb	Sara Buri series
Np	Nakhon Pathom series
Mn	Manorom series
Bo	Boraphet series
Lp	Lampang series


Ban Wang Mai
Ban Wang Ma Nao
Cn
Ban Yan Sawat (2)
MAE NAM NAN
Rb
Cs
Cn
Ban Yan Sawat (3)
Rb
Ban Thap Kra
Yp
Ban Wang Na (1)
Ban Wang Na (2)
BUNG BORAPHET
HUAI PA


Ban Khe Ta Ruang
Ban Po Lamo
Ban Khe Riang Tai
Ban Nong Sa(I)
Ban Khlong Bon
Ban Wang Phradaeo
Ban Nong Khao Kling
Ban Nong Chik Khlong Nua
Ban Dai Marun Tai
Ban Phanom Sat Tai
Ban Wang Maha Kan Nua (2)
Ban Wang Maha Kan Nua (1)
Ban Pak Nam Nua
KHLONG SAI LAMPHONG
KHLONG TAKO
Khlong Phai
Sb
Cs
Mn
Rb
Pm
Gs
Yp


Ban Takhe Khai (1)
Ban Takhe Khai (2)
Ban Sai Lamphong Nua (2)
Ban Noen Tak Sian
Ban Nong Sa(1)
Ban Sai Lamphong Klang
Ban Nong Raman
Ban Sai Lamphong Tai
Ban Noen Tak Sian
Ban Nong Ai Saeng
Ban Wang Yai Nua
Ban Wang Yai Tai
Ban Nong Rakhang
Ban Suphan
Ban Chalom Nae
Ban Nong Khro (2)
Ban Nong Chado Nua
Ban Nong Chado Tai
Ban Pak Khao
Ban Nong Nam Chum
Sc-an
Ban Khao Phanom Rok
Ban Khlong Yang
Mn
Sb
Cs
Np
To
Ty



Sk	Sakon series
Sp-col	San Pa Tong series, colluvial phase

Residuum and Colluviated Residuum

Lb	Lop Buri series
Tk	Takli series
Pa-col	Pak Chong colluvial phase
Ty	Tha Yang series

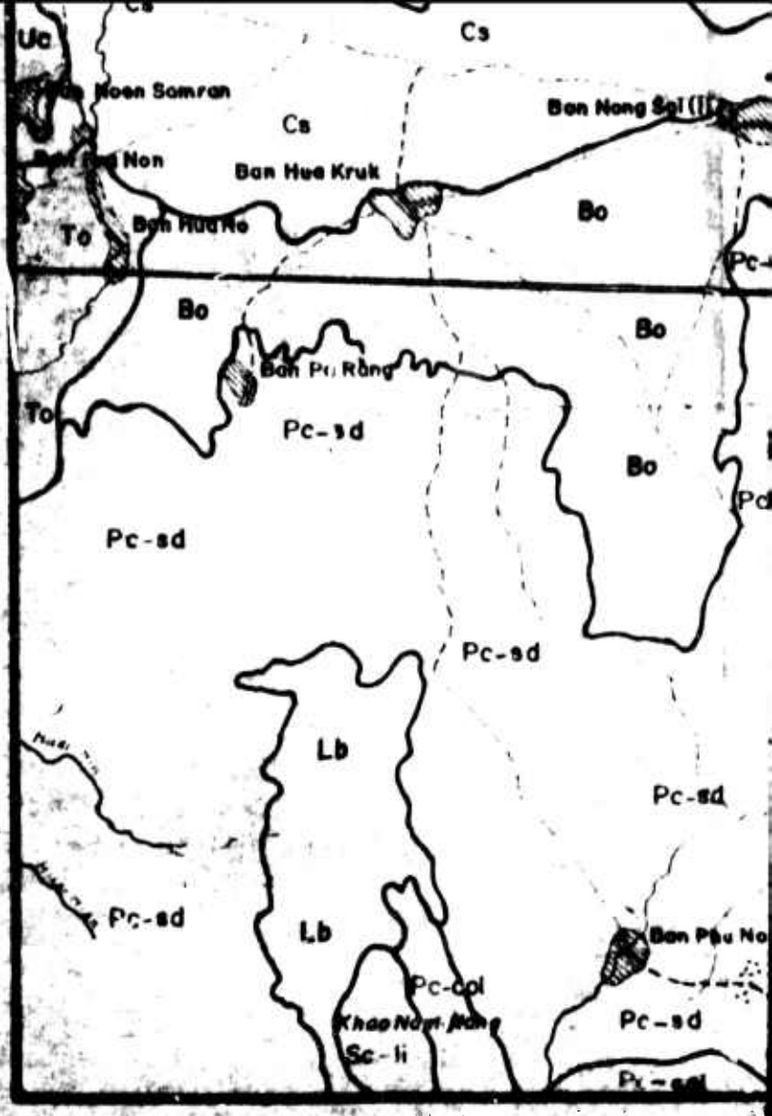
OTHER UNITS

Soil Complexes

Uc	Unnamed complex
Ac	Alluvial complex
Sc	Slope complex

Sc-an : Andesite

15-40



CONVENTIONAL SYMBOLS

Urban

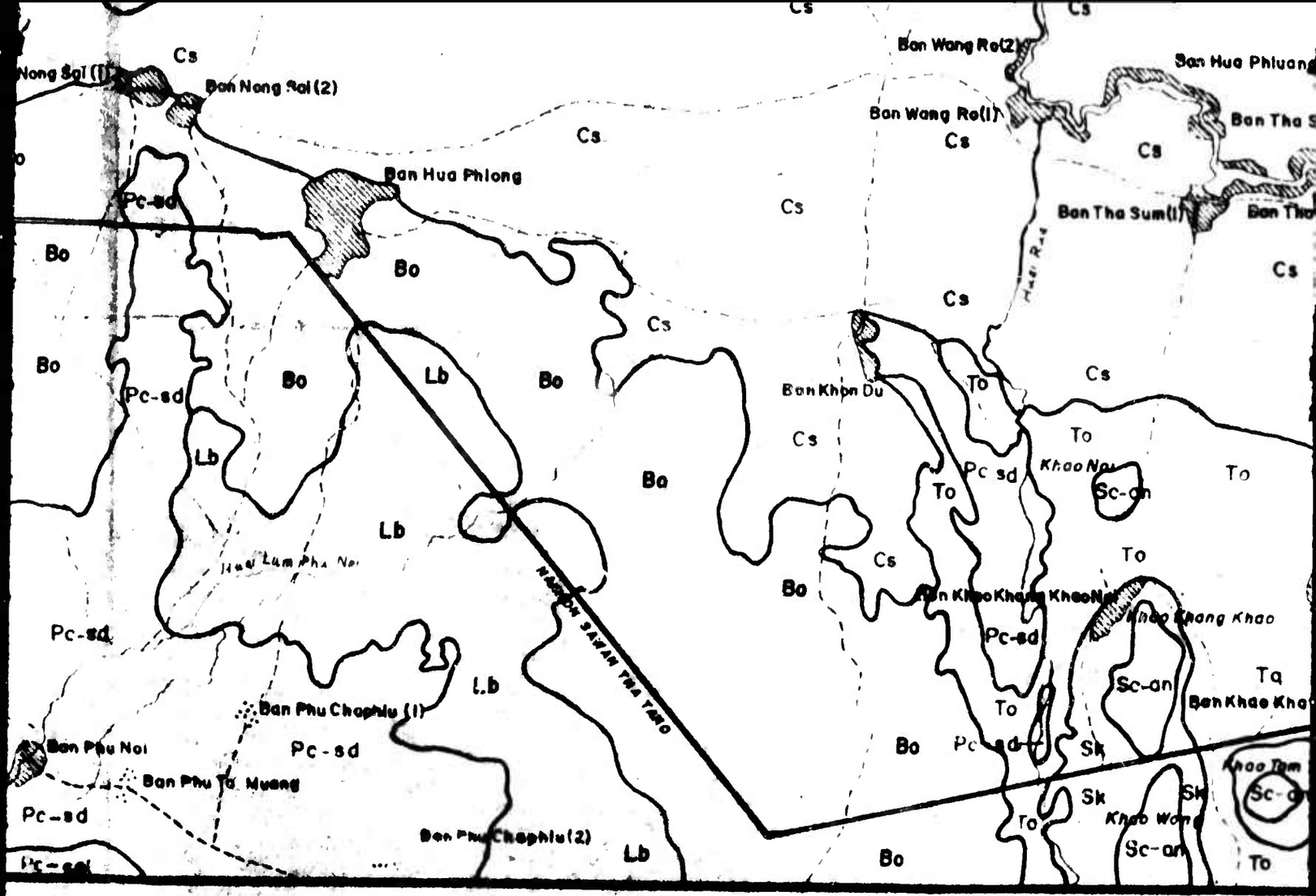
Road

Road under construction

Track and footpath

Railroad (elevated)

Urban road and military street



MBOLS

10

Lake

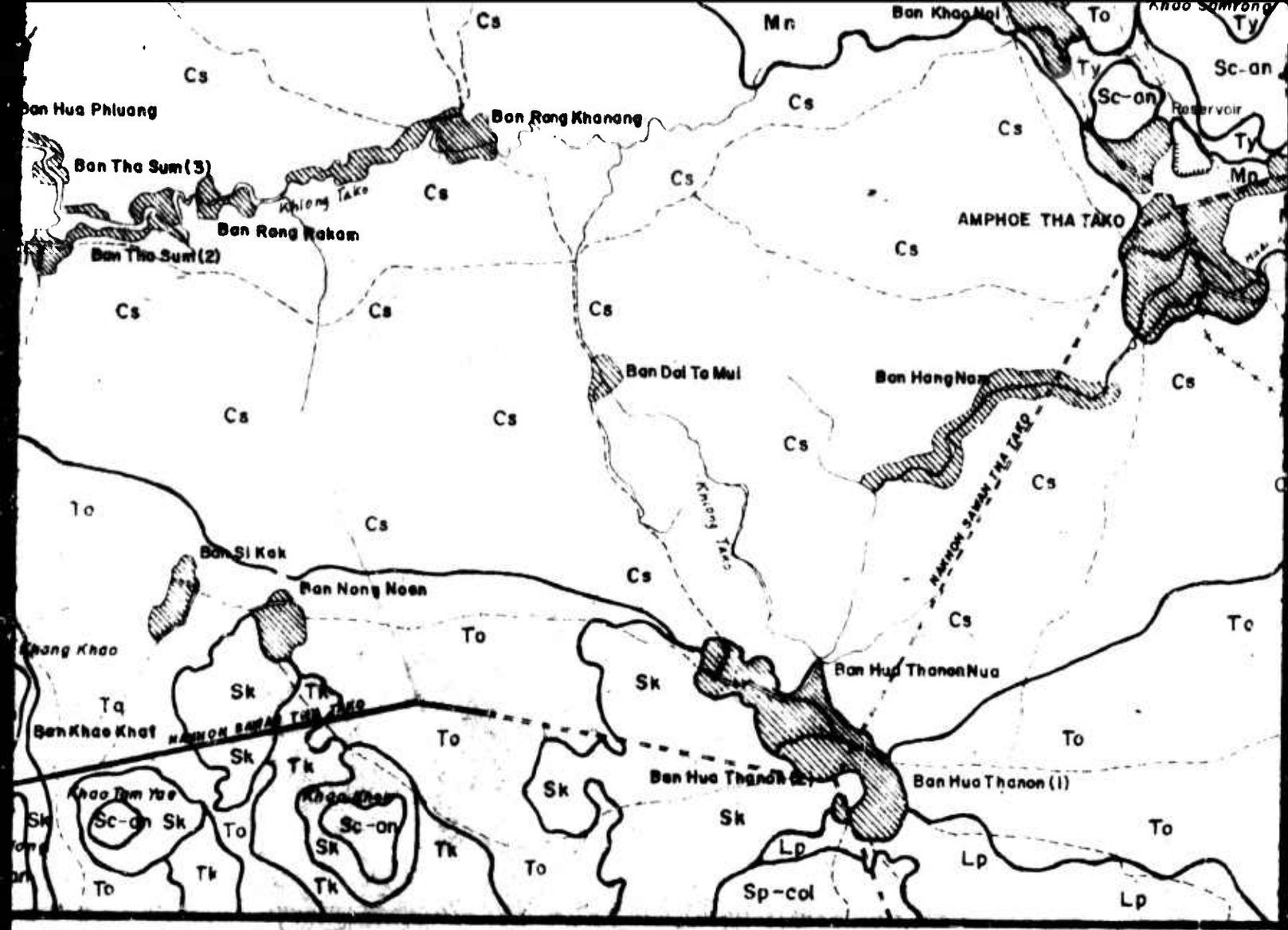
Stream and creek

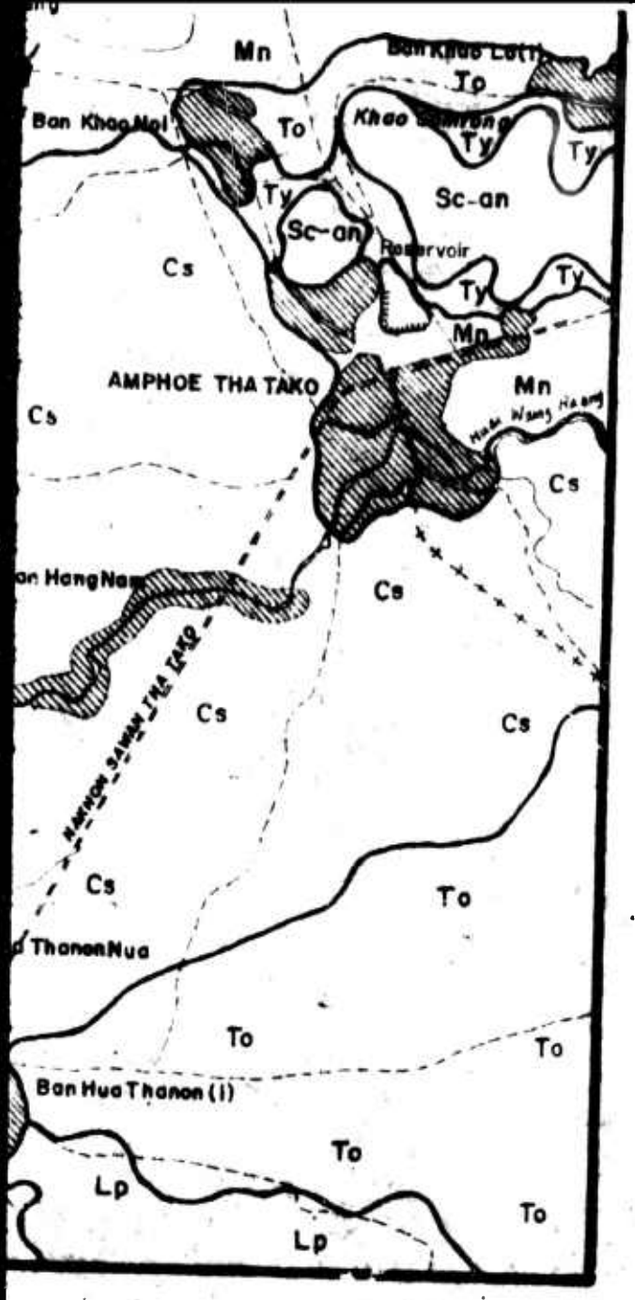
Amphoe boundary

Soil boundary

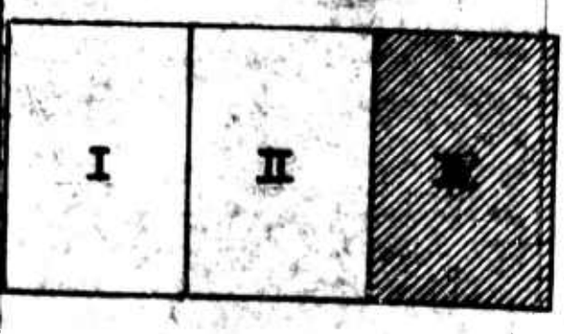
N.

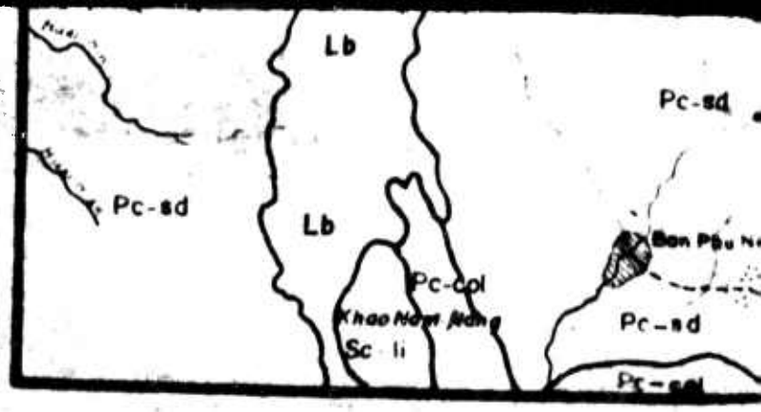
Scale 1:50,000


Cs
Mn
Ban Khao Noi
To
Ty
Khao Samyong
Sc-an
Ban Hua Phluang
Ban Rang Khanang
Ban Tha Sum (3)
Khlong Tako
Ban Rang Rakam
Ban Tha Sum (2)
AMPHOE THA TAKO
Reservoir
Ban Dai Ta Mui
Ban Hang Nam
Khlong Tako
To
Ban Si Kok
Ban Nong Noen
Khang Khao
Sk
Tk
Tq
Ban Khao Khat
Ban Hua Thanon Nua
Ban Hua Thanon (1)
Khao Tam Yae
Sc-on
Lp
Sp-col
INDEX MAP
I
II


Mn
To
Ban Khao Noi
To
Ty
Ty
Ty
Sc-an
Sc-an
Reservoir
Cs
Ty
Ty
Mn
AMPHOE THA TAKO
Mn
Cs
Cs
Cs
Cs
Cs
Cs
To
To
To
Lp
Lp
To
Ban Hua Thanon (i)

INDEX MAP


I
II
III



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CONVENTIONAL SYMBOLS

Urban

Road

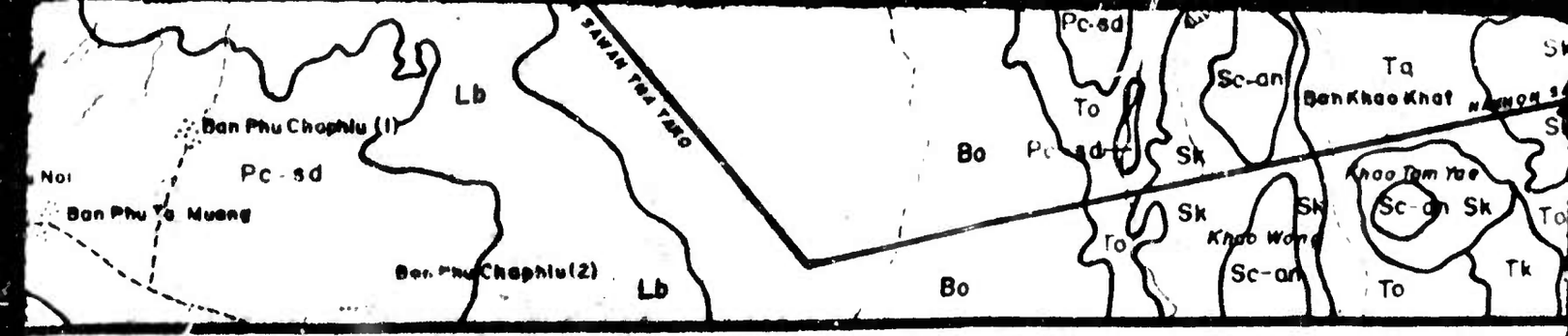
Road under construction

Track and footpath

Railroad (elevated)

Urban road and military street

River



10

Lake

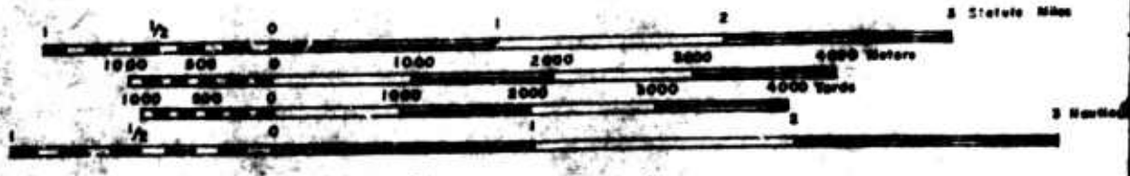
Stream and creek

Amphoe boundary

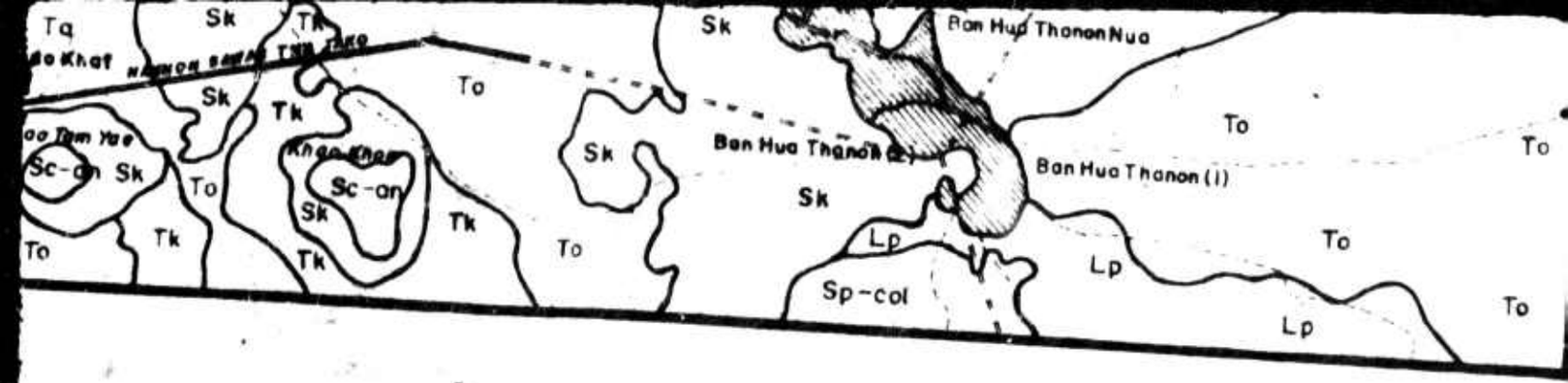
Soil boundary

N.

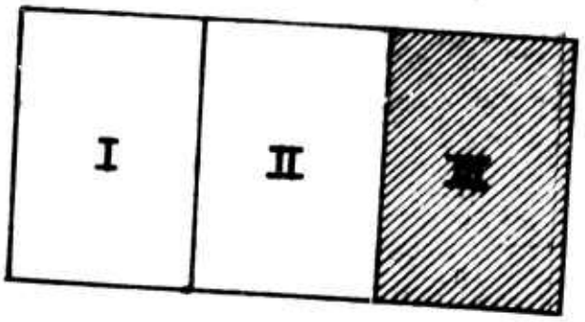
Scale 1:50,000



14



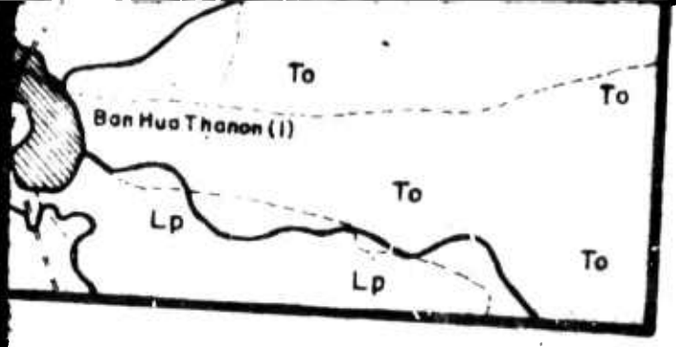
INDEX MAP



NAKH

SURVEY
DRAWN
TRACED
CHECKE

SOIL SURVEY



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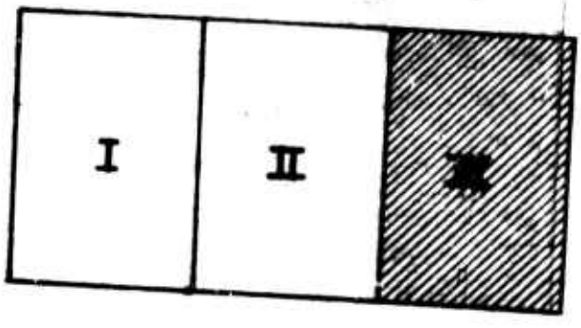
INDEX MAP



KINGDOM OF THAILAND
MINISTRY OF NATIONAL DEVELOPMENT
DEPARTMENT OF LAND DEVELOPMENT

SOIL MAP OF THE MERS
NAKHON SAWAN STUDY AREA, APPA

Sheet III of 3 sheets

SURVEY ...
DRAWN ...
TRACED ...
CHECKED ...

SOIL SURVEY DIVISION, MARCH 1967

SSR 52-3

Topography after A.M.S. series L 708

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EXPLANATO

Soil Formation	Symbol and series name	Great soil group (s)	Parent material
RECENT RIVER ALLUVIUM	Tm Tha Maeng	Alluvial soil	Recent river alluvium
	So Sapphaya	Alluvial soil (hydromorphic)	Recent river alluvium
	Cn Chainat	Alluvial soil (hydromorphic)	Recent river alluvium
	Rb Rat Buri	Alluvial soil (hydromorphic)	Recent river alluvium
	Pm Phimai	Alluvial soil (hydromorphic)	Recent river alluvium
	Yp Yang Pong	Alluvial soil (hydromorphic)	Recent river alluvium
	Cs Chum Saeng	Alluvial soil (hydromorphic)	Recent river alluvium
	To Tha Tako	Alluvial soil and Humic Gley soil	Alluvium and colluvium
TERRACE ALLUVIUM & SLOPE COLLUVIUM	Sb Sara Buri	Humic Gley soil – Alluvial soil intergrade	Semirecent river alluvium
	Nc Nakhon Pathom	Low – Humic Gley soil	Semirecent river alluvium
	Pb Phet Buri	Low – Humic Gley soil	Semirecent river alluvium
	Ks Kamphaeng Saen	Noncalcic Brown soil	Semirecent river alluvium
	Kr Krok Phra	Low – Humic Gley soil	Semirecent river alluvium
	Ub Ubon	Low – Humic Gley soil	Semirecent river alluvium
	Mn Manorom	Low – Humic Gley soil	Semirecent river alluvium
	Bo Borophet	Humic Gley soil	Semirecent river alluvium or colluvium
	Lp Lampang	Low – Humic Gley soil	Terrace sediments
	Sk Sakon	Low-Humic Gley to Gray Podzolic soil	Terrace sediments and some upper colluvium
	Sp Sam Pa Tung	Gray Podzolic soil	Terrace sediments and slope colluvium.
	Ly Lat Ya	Red - Yellow Podzolic soil	Terrace sediments and residuum (?)
UM & COLLUVIATED RESIDUUM	Lb Lop Buri	Black Grumosol	Limestone alluvium and colluvium
	Yt Tak	Rendzina	Colluviated residuum from limestone
	Pc-cd Pak Chong colluvial phase	Red Brown earth to Brown Forest soil	Colluviated residuum from limestone
	Pc-sd Pak Chong shallow dark phase	Red Brown earth to Brown Forest soil	Colluviated residuum from limestone
	Nb Nakhon Sawan	Reddish – Brown Lateritic soil to Red Brown earths	Colluviated residuum from predominantly mica schist

ANATORY LEGEND FOR THE SOILS OF MERS NAKHO

terial	Land form	Topography	Genetic soil horizon	Textural profile	
alluvium	River levees	Flat to slightly undulating, slight slope to the basin.	A – C or Cg	Sandy loam, loam, or silt loam	If pr
alluvium	River levees and levee-basin transition	Flat to slightly undulating, slight slope to the basin.	Apg — Cg	Loam to silt loam	M
alluvium	River levee-basin transition	Flat to slightly undulating	Apg – Cg	Clay loam to silty clay	M
alluvium	River basin	Flat to slightly undulating	Apg – Cg	Clay	M
alluvium	Lower part of river basin	Flat	Apg — Cg	Clay	M
alluvium	Depressions or backswamps	Flat	Ag — Cg	Clay	Blurs surfa
alluvium	River basin	Flat	Apg – Cg	Clay	Matt distin
colluvium	Valleys of creeks, foot slopes of predominantly limestone hills	Flat to slightly undulating	Ag – Cg	Loam or clay	M
alluvium	Lower part of semirecent terrace	Flat to slightly undulating	Apg – Btg	Clay	M
alluvium	Lower part of semirecent terrace	Flat to slightly undulating	Apg – Btg	Clay loam over clay loam to clay	
alluvium	Semirecent river levees	Flat to slightly undulating	Apg – Btg	Fine sandy loam to clay loam	
alluvium	Old and Semirecent river levees	Flat to slightly undulating	A – Bt or Btg	Fine sandy loam to clay loam	If p
alluvium	Semirecent terrace	Flat to slightly undulating	Ag – Btg (?)	Loamy sand to sandy loam over clay loam to clay	
alluvium	Semirecent terrace	Flat to slightly undulating	Ag – Btg (?)	Sand to loamy sand throughout	
alluvium	Semirecent terrace	Flat to slightly undulating	Ag – Btg (?)	Clay loam over clay	Matt distin
alluvium	Semirecent terrace – peneplains transition	Flat to slightly undulating	Ag – Bg or Cg	Clay	Matt stra
diments	Low terrace, partly colluviated.	Flat to slightly undulating	Ag — B	Loamy sand to sandy loam over sandy loam to sandy clay loam	Matt distin
and some	Low terrace, some colluvial slopes	Slightly undulating to undulating	A-Bt or Ag-Btg, laterite pan	Sandy loam to clay loam	Matt rlee
and slope	Low terrace and colluvial slopes	Flat to slightly undulating	A1-A2-Bt (weak) or Ap-Bt	Loamy sand to sandy loam over sandy loam to sandy clay loam	If pre
and residuum	High terrace, some colluvial slopes	Slightly undulating to undulating	A – Bt	Sandy loam	
colluvium	Peneplains	Flat to slightly undulating	A – Cg or Ag – Cg (indistinct)	Clay	Indist
from limestone	Peneplains	Undulating	A – C or A – (B) – C	Clay	
from limestone	Colluvial slopes	Undulating to rolling	A1 (Ap) – A3 – Bt or A – Bt	Clay loam over clay	If pr
from limestone	Peneplains	Slightly undulating to undulating	A1 (Ap) – A3 – Bt or A – Bt	Clay	
from schist	Colluvial slopes	Undulating to rolling	A — Bt	Loam over clay loam	
from	Colluvial slopes	Undulating to rolling	A — Bt	Clay loam over clay	

NAKHON SAWAN STUDY AREA

Diagnostic characteristics

e	Gley	Colors below A horizon	pH	Other characteristics
oam	If present, only in sub soil	Dark grayish brown or brown to yellowish brown	5·5 — 6·5	Contains mica throughaut the profile, mica along Mae Nam Ping.
m	Mattled throughaut	Pale brown or very pale	5·5 — 6·5	Contains mica thraughout the pratile
ay	Mottled throughout	Brawn to yellowish brown	Surface 5 — 5·5 Subsoil 6·5 — 7	Mica seldam found in this soil
	Mattled throughout	Grayish brown to yellawish brown	5 — 6·5	Rb-ca : calcareous phase, pH 6—6 5 S flagments on the surface.
	Mottled throughout	Gray to olive groy	Surface 5·5 — 6·5 Subsoil 6·5 — 7	Same profiles show red mattles in the subso depth.
	Bluish reduction below the surfoce layer	Bluish to gray	5 — 6·5	Flooded nearly throughout the year, in some gravels are found in the surfoce layer
	Mottled thraughaut, very distinct strang red	Pinkish gray to groy	4·5 — 5·5	In certoincases Cs soils are similor to Mn differentioted by topography, the lawer part
	Mattled throughout	Dark groyish brown to olive brown	7 — 8	Rock fragments of limestone, quartzite ond are found in some areo
	Mattled throughout	Dark brown or yellawish brown	Surface 5 — 5·5 Subsoil 5 5 — 7	Comparable to Rb soil, but found in higher p associated with termite hills
n to	Mottled throughout	Very dark grayish brown or yellowish brown.	Surface 5 — 5·5 Subsoil 6 5 — 7	Some soils with coarser texture top soil (loam) subsoil (sandy loam) are also admitted. Np-a acid p 4·5 — 5
m	Mattled throughout	Brown to yellawish brown	5 — 6·5 increase with depth	Comparable with Ks soil, but used for rice
am	If present, only in sub soil	Yellowish brown to brown	5 — 6·5 increase with depth	Ks-l : leached phase, loamy sand, mica, dark surface wi Ks-mo : mottled phase, loam to clay loam, dark surface
m	Mattled throughout	Grayish brown to brown	Surface 5 — 5·5 Subsoil 6·5 — 7	Mostly contains mica at the surface. The profiles loam texture throughout are also admitted in to
out	Mottled throughout	Brown to light yellowish brown	4·5 — 5·5	Comparable to Sp-s and Ks-l, but use for rice, profile
	Mattled throughout, very distinct strong red mottles	Gray to light brownish gray	4·5 — 5·5	Comparable to Cs soils but situated in higher pos ciated with termite mounds, slightly light texture i better drainage and often granular structure in the
	Mattled throughout, distinct strong red mottles	Grayish brown to gray	Surface 6 — 7 Subsoil 4·5 — 5·5	Surface layer comparable to Lb, and sub surface com
er m	Mottled throughout, very distinct to distinct strong red mo.	Grayish brown to light brownish gray	4·5 — 5·5	Lp-cc Concretionary phase, ground water laterite Lp-cl Clayey subsoil phase, heavy clay from 20— strong red mottling.
	Mottled throughout only in rice land	Dark grayish brown to brown	4·5 — 6	Pan of hard laterite occurs at less than 50 c sometimes laterite exposed at the surface
ver m	If present, only in sub soil	Reddish yellow to brown	Surface 5·5 — 6 Subsoil 5 — 5·5	Sp-s : Sandy phase, loamy sand, comparable to Ks-l Sp-col : colluvial phase, loamy sand with mottled
	——	Yellowish red to strong brown	4·5 — 5·5	Residuum in areas mixed with limestone, high pH v of mixing with limestone are admitted.
	Indistinct mottling throughout	Gray to grayish brown	7 — 8	Selfmulching surface
	——	Gray to dark gray	7 — 8	Shallow layer of marly limestone beneath the dark h
	If present only in subsoil	Red to yellowish red	Surface 7 — 8 Subsoil 6 — 6·5	Limestone fragments throughout
	——	Dark reddish brown or reddish brown.	7 — 8	Limestone fragments below 50 — 70 cm.
	——	Dark red to yellowish red	8·8 — 9	——
	——	Red	6·5	

EA

pH	Other characteristics	Dominant landuse or Vegetation
5 5 — 6·5	Contains mica throughout the profile, mico most abundant along Mae Nam Ping.	Mostly urban, some gardens, orchards & dryland
5 5 — 6·5	Contains mica throughout the profile	Rice
5 — 5 5 6 5 — 7	Mica seldom found in this soil	Rice and some dryland crops, corn, jute
5 — 6·5	Rb - ca : calcareous phase, pH 6 — 6·5. Some limestone flagments on the surface.	Mostly rice, some bamboo forest
5·5 — 6·5 6·5 — 7	Some profiles show red mottles in the subsoil at varying depth.	Marshy, and some rice
5 — 6·5	Flooded nearly throughout the year, in some profiles laterite gravels are found in the surface layer	Mostly marshy some lotus growing on the upper parts
4·5 — 5 5	In certaincases Cs soils are similar to Mn soil but they are differentiated by fapography, the lower part being Cs soils	Rice
7 — 8	Rock fragments of limestone, quartzite and laterite gravels are found in some area.	Rice
5 — 5·5 5 5 — 7	Comparable to Rb soil, but found in higher position and associated with termite hills.	Rice
5 — 5·5 6 5 — 7	Some soils with coarser texture top soil (loam) and lighter in subsoil (sandy loam) are also admitted. Np-a acid phase, pH subsoil 4·5 — 5	Rice
5 — 6·5 creose with depth	Comparable with Ks soil, but used for rice	Rice
5 — 6·5 creose with depth	Ks-l : leached phase, loamy sand, mica, dark surface with brown subsoil Ks-ma : mottled phase, loam to clay loam, dark surface with brown subsoil	Dryland crops, corn, sugar, jute and some shrubs.
5 — 5·5 6·5 — 7	Mostly contains mica at the surface. The profiles with sandy loam texture throughout are also admitted in to this series	Rice
5 — 5·5	Comparable to Sp-s and Ks-l, but use for rice; no mica in the profile	Rice
5 — 5 5	Comparable to Cs soils but situated in higher position and associated with termite mounds, slightly light texture in surface better drainage and often granular structure in the surface.	Mostly rice, some ground nuts
6 — 7 4·5 — 5 5	Surface layer comparable to Lb, and sub surface comparable to Cs	Dryland crops, corn, and beans, bamboo & grass.
5 — 5 5	Lp-cc Concretionary phase, ground water laterite below 50 cm Lp-cl Clayey subsoil phase, heavy clay from 20—50 cm. very strong red mottling.	Rice and some bamboo, shrubs
5 — 6	Pan of hard laterite occurs at less than 50 cm. depth, sometimes laterite exposed at the surface	Shrubs, some rice and dryland crops
5·5 — 6 5 — 5·5	Sp-s : Sandy phase, loamy sand, comparable to Ks-l but no mica Sp-col : colluvial phase, loamy sand with mottled subsoil	Shrubs, barren and some dryland crops
5 — 5·5	Residuum in areas mixed with limestone, high pH values because of mixing with limestone are admitted.	Shifting cultivation, shrubs and some kapok
— 8	Selfmulching surface	Bamboo, shrubs and some corn
— 8	Shallow layer of marly limestone beneath the dark heavy clay surface	Mostly corn, some shrubs and bamboo.
7 — 8 6 — 6·5	Limestone fragments throughout	Shrubs and corn
— 8	Limestone fragments below 50 — 70 cm.	Corn, castor beans, bamboo and shrubs.
5 — 7	—	Bamboo & shrubs, some corn.
6·5	—	Vegetable gardens & fruit orchards

TERRACE ALLUVIUM & SLOPE COLLUVIUM	Np	Nakhon Pathom	Low-Humic Gley soil	Semirecent river alluvium
	Pb	Phet Buri	Low-Humic Gley soil	Semirecent river alluvium
	Ks	Kamphaeng Saen	Noncalcic Brown soil	Semirecent river alluvium
	Kr	Krok Phra	Low-Humic Gley soil	Semirecent river alluvium
	Ub	Ubon	Low-Humic Gley soil	Semirecent river alluvium
	Mn	Manorom	Low-Humic Gley soil	Semirecent river alluvium
	Bo	Borophet	Humic Gley soil	Semirecent river alluvium or colluvium
	Lp	Lampang	Low-Humic Gley soil	Terrace sediments
	Sk	Sakon	Low-Humic Gley to Gray Podzolic soil	Terrace sediments and some slope colluvium
	Sp	San Pa Tong	Gray Podzolic soil	Terrace sediments and slope colluvium
	Ly	Lat Ya	Red-Yellow Podzolic soil	Terrace sediments and residu (?)
RESIDUUM & COLLUVIATED RESIDUUM	Lb	Lop Buri	Black Grumosol	Limestone alluvium and colluvium
	Tk	Takli	Rendzina	Colluviated residuum from limeston
	Pc-sol	Pak Chong colluvial phase	Red Brown earth to Brown Forest soil	Colluviated residuum from limeston
	Pc-sd	Pak Chong shallow dark phase	Red Brown earth to Brown Forest soil	Colluviated residuum from limesto
	Ns	Nakhon Sawan	Reddish-Brown Lateritic soil to Red Brown earths	Colluviated residuum from predominantly mica schist
	Li	Li	Reddish-Brown Lateritic soil	Colluviated residuum from various rocks (shale, andesite, etc)
	Ty	The Yang	Red Yellow Podzolic soils, some lithosols.	Stony colluvium and residuum from acidic rocks

Other units

SOIL COMPLEXES	Symbol and Soil Complex name	Composition
	Uc Unnamed complex	Unnamed complex of Ty, Ly, Tk, Pc-sd, Ns and
	Ac Alluvial complex	Complex of Tm, Se, Cn, Rb, Pm, Yp series, usually along the
	Sc Slope complex	Mostly Gray Podzolic soils, shallow and stony, with Red-Yell Red Brown earth, Rendzina and Brown Forest soils
	Ks-c Kamphaeng Saen complex	Complex of Ks-l, Np, Pb, Pm, and some Yp

ASSOCIATIONS	Symbol and association name	Composition
	Ks/Pb Kamphaeng Saen and Phet Buri	Mainly Ks, lower Pb spots
	Lp/Sp Lampang and San Pa Tong	Mostly Lp, isolated islands
	Ty/Ns The Yang and Nakhon Sawan	Mainly Ty; Ns soil depth m

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luvium	Lower part of semirecent terrace	Flat to slightly undulating	Apg – Btg	clay	M
luvium	Semirecent river levees	Flat to slightly undulating	Apg – Btg	Fine sandy loam to clay loam	Mo
luvium	Old and Semirecent river levees	Flat to slightly undulating	A – Bt or Btg	Fine sandy loam to clay loam	If pre
luvium	Semirecent terrace	Flat to slightly undulating	Ag – Btg (?)	Loamy sand to sandy loam over clay loam to clay	Mo
luvium	Semirecent terrace	Flat to slightly undulating	Ag – Btg (?)	Sand to loamy sand throughout	Mo
luvium	Semirecent terrace	Flat to slightly undulating	Ag – Btg (?)	Clay loam over clay	Mottled distinct
luvium	Semirecent terrace – peneplain transition	Flat to slightly undulating	Ag – Bg or Cg	Clay	Mottled strong
ments	Low terrace, partly colluviated.	Flat to slightly undulating	Ag – B	Loamy sand to sandy loam over sandy loam to sandy clay loam	Mottled distinct
and some	Low terrace, some colluvial slopes	Slightly undulating to undulating	A – Bt or Ag – Btg, latsrite pan	Sandy loam to clay loam	Mottled rice lo
and slope	Low terrace and colluvial slopes	Flat to slightly undulating	A1 – A2 – Bt (weak) or Ap – Bt	Loamy sand to sandy loam over sandy loam to sandy clay loam	If prese
and residuum	High terrace, some colluvial slopes	Slightly undulating to undulating	A – Bt	Sandy loam	
colluvium	Peneplains	Flat to slightly undulating	A – Cg or Ag – Cg (indistinct)	Clay	Indistinc
m limestone	Peneplains	Undulating	A – C or A – (B) – C	Clay	
m limestone	Colluvial slopes	Undulating to rolling	A1 (Ap) – A3 – Bt or A – Bt	Clay loam over clay	If prese
m limestone	Peneplains	Slightly undulating to undulating	A1 (Ap) – A3 – Bt or A – Bt	Clay	
from schist	Colluvial slopes	Undulating to rolling	A – Bt	Loam over clay loam	
from esite, etc)	Colluvial slopes	Undulating to rolling	A – Bt	Clay loam over clay	
d residuum	Low hills and knolls	Rolling	A – Bt or A – C	Gravelly sandy loam over gravelly sandy clay loam	

ion	Parent material	Physiographic position	
sd, Ns and Lp (High variant)	Colluviated residuum of various kinds of rocks.	Peneplains	
along the river or at junction of rivers	Recent river alluvium	Alluvial plains	Distin
Red – Yellow Podzolic soils, Reddish – Brown Lateritic soils ils	Diverse	Hills and mountains	
some Yp series	Semirecent river alluvium	Old river levees	Flat to

position and situation		
Pb spots under rice		Flat
d islands of Sp, under dipterocarp forest or shrubs		Flat
oil depth more than 50 cm, Tp soil shallow and stony		

Mottled throughout	very dark grayish brown or yellowish brown	Surface 5 – 5 5 Subsoil 6 5 – 7	Some soils with coarser texture top soil (loam to subsoil (sandy loam) are also admitted Np-a acid pho 4 5 – 5
Mottled throughout	Brown to yellowish brown	5 – 6 5 increase with depth	Comporable with Ks soil, but used for rice
If present, only in sub soil	Yellowish brown to brown	5 – 6 5 increase with depth	Ks-l: leached phase, loamy sand, mica, dark surface with Ks-mo mottled phase, loam to clay loam, dark surface wi
Mottled throughout	Grayish brown to brown	Surface 5 – 5 5 Subsoil 6 5 – 7	Mostly contains mica of the surface The profiles w loam texture throughout are also admitted in to thi
Mottled throughout	Brown to light yellowish brown	4 5 – 5 5	Comparable to Sp-s and Ks-l, but use for rice, n profile
Mottled throughout, very distinct strong red mottled	Gray to light brownish gray	4 5 – 5 5	Comporable to Cs soils but situated in higher positi ciated with tsrmite mounds, slightly tight texture in better drainage and often granular structure in the su
Mottled throughout, distinct strong red mottles	Grayish brown to gray	Surface 6 – 7 Subsoil 4 5 – 5 5	Surface layer comparable to Lb, and sub surface compa
Mottled throughout, very distinct to distinct strong red mo.	Grayish brown to light brownish gray	4 5 – 5 5	Lp-cc Concretionory phase, ground water laterite b Lp-cl Clayey subsoil phase, heavy clay from 20–5 strong red mottling
Mottled throughout only in rice land	Dark grayish brown to brown	4 5 – 6	Pan of hard laterite occure at less than 50 cm sometimes laterite exposed at the surface
If present, only in sub soil	Reddish yellow to brown	Surface 5 5 – 6 Subsoil 5 – 5 5	Sp-s Sandy phase, loamy sand, comporable to Ks-l b Sp-col colluvial phase, loamy sand with mottled s
———	Yellowish red to strong brown	4 5 – 5 5	Residuum in areas mixed with limestone, high pH va of mixing with limestone are admitted
Indistinct mottling throughout	Gray to grayish brown	7 – 8	Selfmulching surface
———	Gray to dark gray	7 – 8	Shallow layer of marly limestone beneath the dark hea
If present only in subsoil	Red to yellowish red	Surface 7 – 8 Subsoil 6 – 6 5	Limestone fragments throughout
———	Dark reddish brown or reddish brown	7 – 8	Limestone fragments below 50 – 70 cm.
———	Dark red to yellowish red	6 5 – 7	———
———	Red	6 5	———
———	Yellowish red to strong brown	4 5 – 5 5	Shallow soils, often only weak profile developm

Topography	Subdivision according to dominant rocks				
Undulating					
Distinct micro – relief					
Rolling to steep	Sc-li Hard limestone, craggy hills, many rock out crops	Sc-an: Andesite, round hills and monadnocks, few rock out crops	Sc-ms: mostly mica schist, some quartzite, round hills, few rock out crops	Sc-ai Acid igneous rock, dominantly diorite or granodiorite, round hill, few rock out crops	Sc-ms-li(bl) schist some basic rocks hill, few rock
Flat to slightly undulating					

Topography	
Flat to slightly undulating	
Flat to slightly undulating	
Undulating	

oil 6 5 — 7 5 — 6 5 increase with depth	subsoil sandy loam) are also admitted. Np-6 acid phase, pH subsoil 4 5 — 5	Rice
	Comparable with Ks soil, but used for rice	Rice
5 — 6 5 increase with depth	Ks-l: leached phase, loamy sand, mica, dark surface with brown subsoil Ks-ma mottled phase, loam to clay loam, dark surface with brown subsoil	Dryland crops, corn, sugar, jute and some shrubs
face 5 — 5 5 soil 6 5 — 7	Mostly contains mica at the surface. The profiles with sandy loam texture throughout are also admitted in to this series	Rice
4 5 — 5 5	Comparable to Sp-s and Ks-l, but use for rice, no mica in the profile	Rice
4 5 — 5 5	Comparable to Ce soils but situated in higher position and associated with termite mounds, slightly light texture in surface, better drainage and often granular structure in the surface	Mostly rice, some ground nuts
face 6 — 7 soil 4 5 — 5 5	Surface layer comparable to Lb, and sub surface comparable to Cs	Dryland crops, corn, and beans, bamboo & grass
4 5 — 5 5	Lp-cc Concretionary phase, ground water laterite below 50 cm Lp-cl Clayey subsoil phase, heavy clay from 20–50 cm. very strong red mottling	Rice and some bamboo, shrubs
4 5 — 6	Pan of hard laterite occurs at less than 50 cm. depth, sometimes laterite exposed at the surface	Shrubs, some rice and dryland crops
ace 5 5 — 6 oil 5 — 5 5	Sp-e. Sandy phase, loamy sand, comparable to Ks-l but no micas Sp-col. colluvial phase, loamy sand with mottled subsoil	Shrubs barren and some dryland crops
4 5 — 5 5	Residuum in areas mixed with limestone, high pH values because of mixing with limestone are admitted	Shifting cultivation, shrubs and some kapok
7 — 8	Selfmulching surface	Bamboo, shrubs and some corn
7 — 8	Shallow layer of marly limestone beneath the dark heavy clay surface	Mostly corn, some shrubs and bamboo.
ace 7 — 8 oil 6 — 6 5	Limestone fragments throughout	Shrubs and corn
7 — 8	Limestone fragments below 50 — 70 cm.	Corn, castor beans, bamboo and shrubs
5 5 — 7	——	Bamboo & shrubs, some corn
6 5	——	Vegetable gardens & fruit orchards
4 5 — 5 5	Shallow soils, often only weak profile development	Shrubs and bamboo, some corn and castor beans

according to dominant rocks				Vegetation
				Corn, rice, shrubs and grass
				Marsh vegetation, and shrubs, rice and vegetables
rte, round hills ocks, few aps	Sc-ms mostly mica schist, some quartzite, round hills, few rock out crops	Sc-ai Acid igneous rock, dominantly diorite or granodiorite, round hill, few rock out crops	Sc-ms-li(bl): Mostly mica schist some limestone and basic rocks inclusions, round hill, few rock out crops	Dipterocarp forest, bamboo and shrubs
				Dryland crops, rice and marsh vegetation
				Vegetation
				Shrubs, scattered rice fields.
				Rice, dipterocarp forest and shrubs
				Mostly shrubs, some dryland crops